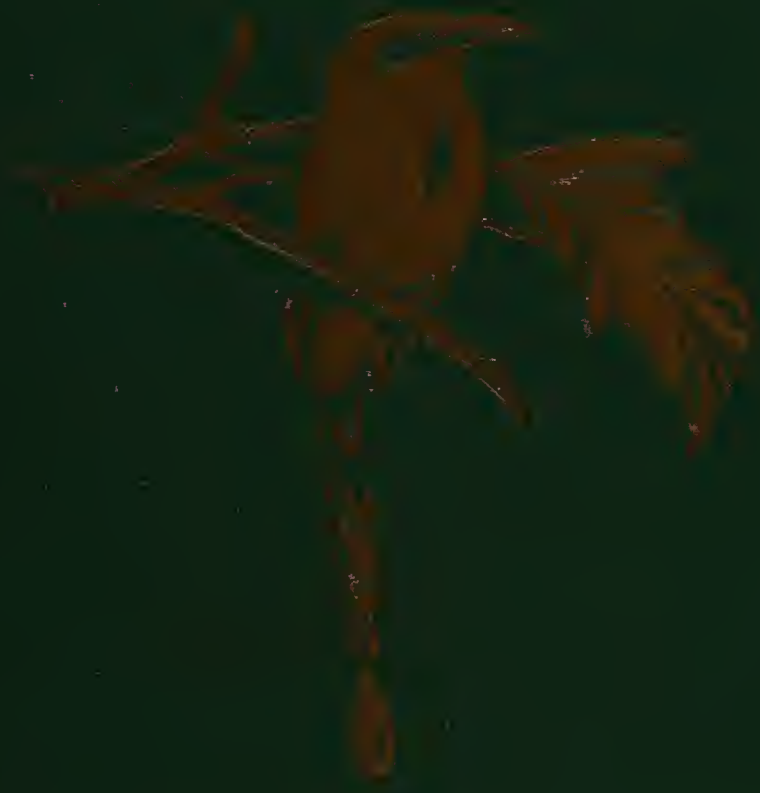
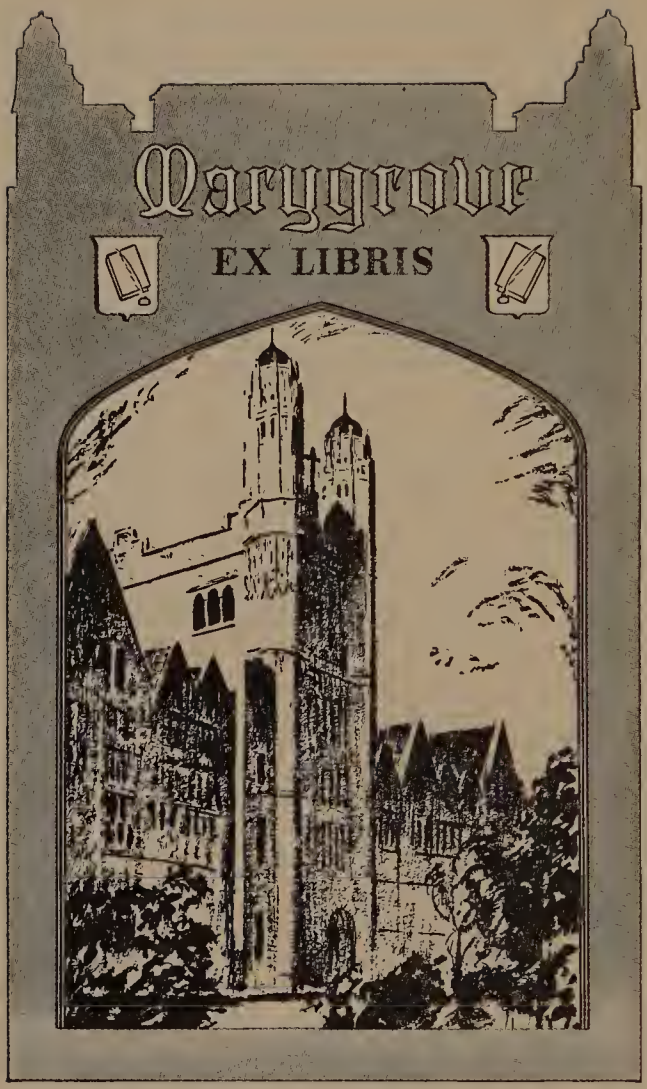
MY TROPICAL AIR CASTLE



FRANK M. CHAPMAN



GIFT OF Mrs. Perry J. Reynolds

574.986
C36

WITHDRAWN

MY TROPICAL AIR CASTLE

A Little Dwelling Which I Call My Own

MY TROPICAL AIR CASTLE

NATURE STUDIES IN PANAMA

BY

FRANK M. CHAPMAN

CURATOR OF BIRDS IN THE
AMERICAN MUSEUM OF NATURAL HISTORY

Illustrated with drawings by
Francis L. Jaques
and from photographs by the Author

D. APPLETON AND COMPANY
NEW YORK ⁘ LONDON ⁘ MCMXXIX

COPYRIGHT, 1929, BY
D. APPLETON AND COMPANY

PRINTED IN THE UNITED STATES OF AMERICA

Dedicated to

THOMAS BARBOUR AND JAMES ZETEK

THE BUILDERS, AND TO

DONATO AND ENEMICIA

THE KEEPERS OF THE CASTLE

INTRODUCTORY

E all have our "Castles in the Air" but few of us, to use Thoreau's words, succeed in putting "the foundation under them." Ever since, as a boy, I read Bates' "Naturalist on the Amazon" and Wallace's "Travels in the Malay Archipelago" my castle has been in the tropics. For my own northern woods and fields I have the affection born of long and close association; but they lack the romance, the mystery, the enchantment, the inexhaustible possibilities of tropical forests and swamps. One forms a lasting and intimate friendship with nature in the north, but falls hopelessly in love with her in the south. But even while she lures she repels and perhaps herein lies her endless fascination. One is never quite sure of her. Her most winsome aspect may be deceptive, or it may be a dream of rare delight.

It was this "wanton" aspect of tropical nature that drove Burroughs back from her to his own familiar orchards and woods. But Kingsley, because his heart had long been in the tropics, saw only their beauty

and their charm when in "At Last" his dream of visiting them became a reality.

My wish to visit the tropics was long since gratified and for many years, with increasing joy, I have returned to them. But never had I found the home of my heart's desire.

Camps I have had in many strange and beautiful places, and I have occupied native dwellings in remote corners of forest and mountain. But none has been a real home and few have been in truly primeval surroundings. In truth, it is no easy matter to establish one's residence in a primitive tropical region. The more accessible places have long since been inhabited and the areas tributary to them have been more or less altered by native occupation. It requires a well-equipped expedition and the conquest of the inevitable difficulties of transportation to get far from the haunts of man. This might be arranged on occasion but it was impracticable for a brief vacation, and the attendant conditions were apt to reveal the worst instead of the best side of nature—as well as of man.

What I wanted was a permanent home to which I could return year after year with ever-growing pleasure, situated at the border of a primeval tropical forest, looking over water to distant mountains, where the members of a practically undisturbed

fauna should be my daily, if unseen, companions, where living conditions imposed no handicap of hardship or discomfort on my powers of observation or enjoyment, in a region that was beautiful, healthful, and accessible.

This was a castle so high in the air that it never occurred to me even to try to put the foundation under it, when, behold! I found castle and foundation complete on Barro Colorado, an island in the Panama Canal Zone. Nor did the wonder end here, for the castle was furnished with so great a variety of useful, beautiful, and interesting things that every need for the comfort of the body and enrichment of the mind was gratified. Such an amazing experience, it has seemed to me, should be described in an attempt to share it with others. The world has great need of Barro Colorados.

F. M. C.

Barro Colorado,
March, 1929.

CONTENTS

CHAPTER		PAGE
	INTRODUCTORY	vii
I.	BARRO COLORADO	1
II.	CASA MIA	20
III.	IN AND ABOUT THE CLEARING	34
IV.	THE OROPÉNDOLAS OF LABORATORY HILL	78
V.	TWO WIDOWS OF THE SANDBOX TREE	122
VI.	DOES THE TURKEY BUZZARD FOLLOW HIS NOSE?	147
VII.	THE FOREST TRAILS	167
VIII.	WHO TREADS OUR TRAILS?	196
IX.	CAYUCA WAYS	220
X.	THE VOICES OF TROPICAL BIRDS	252
XI.	THE MONKEYS	282
XII.	PRESENTING THE COATI	327
XIII.	TROPICAL FOREST BIRD-LIFE	346
XIV.	OFF THE ISLAND	374
	APPENDIX: A LIST OF BIRDS OF BARRO COLORADO	399
	INDEX	411

PLATES

A Little Dwelling Which I Call My Own . . . . *Frontispiece*

FACING PAGE

Barro Colorado and Gatun Lake from an Altitude of between 11,500 and 12,000 Feet 4
The Clearing and Buildings of the Institute for Research in Tropical America 5
Howling Monkeys Feeding 20
Trapping a Robber 20
The Sandbox Tree 21
The Laboratory from the Lake 28
The Lake from the Laboratory 28
The Forest at the Eastern Border of the Clearing 29
Ghiesbrecht's Hawk 29
Swainson's Toucans and Crested Guan 52
"Poor-me-One" 53
An Avian Apartment 60
The Hummer's Nest of 1926 61
The Hummer's Nest of 1927 61
An Oropéndola Wooing 82
The Oropéndola Colony 83
A Student of Oropéndolas 83
A Parasitic Flycatcher 114
A Group of Oropéndola Nests 115
The Fallen Sandbox Tree 115
A Buzzard on the Shannon Shack 154
A Turkey Buzzard Finds the Bait 154
The American Museum's Habitat Group of Barro Colorado 155
The Forest from My Doorstep 176
Strangler Figs and Their Victims 177
My First Puma 180
A Not Fully Grown Puma 181
Dyson's Puffbird 188
The Canal, Looking North from the Tower 188

PLATES

FACING PAGE

The Mainland from Redwood House 189
A Lookout on the Wheeler Trail 192
A Collared Peccary Passes beneath the Wire 192
A Tayra on the Armour Trail 193
White-lipped Peccaries 193
A Fully Grown Puma 206
Through the Peace of the Night 207
An Ocelot on the Drayton Trail 210
An Ocelot at the End of the Wheeler Trail 211
A Tapir Takes a Banana 214
A Tapir Portrait 215
A Bat on the Armour Trail 216
A Bat (*Artibeus*) Fires the Flash 216
Opossum 217
Agouti 217
White-lipped Peccaries on the Drayton Trail 218
The Camera-Trap 219
The Camera Traps a Man 219
The Haunts of the Tapir 228
A Tapir Emerges 229
Redwood House 236
An Immature Jacana 236
The Grassy Islands 237
Claudia in a Contemplative Mood 320
Claudia's Midday Siesta 320
Claudia Howls 321
Claudia Reacts to a Mouse 321
A Coati Fires the Flash 328
A Coati Takes Possession of a Banana Plant 329
A Coati Portrait 336
The Taming of Peter 336
A Coati Attacks 337
Blue-winged Teal at Pacora 390
The Pacora Marshes 390
Where Martins Roost 391
The Savanna of Panama 391

ILLUSTRATIONS IN THE TEXT

PAGE

Map of Canal Zone and Barro Colorado 3
Rufous Motmot 42
Aracari Toucans in the Mangabé Tree 51
A Graceful Trogon "Catching" Fruit 54
Squirrel Cuckoos 63
Anis 72
Lawrence's Woodcreeper 76
Female Oropéndolas Discussing Nest-Sites 90
Cotinga near Her Nest 125
Black-throated Hummingbird Feeding Young 135
Young Hummingbirds in Nest 138
A Young Hummingbird Tries Her Wings 143
Courtship of a Red-capped Manakin 176
Gould's Manakin 178
Lawrence's Antpitta 183
"Coq Bois" 184
Wood Rails 239
Bat Falcon and Its Prey 241
Purple Gallinules 246
White-throated Rail 250
Chestnut-headed Tinamou 260
Wood Wren 265
Lawrence's Wren 269
Song of the Ant-Tanager 271
Blue Grosbeak's Song 272
Wood Quail 276
Talamanca Jay 280
The Howling Monkey's "Loud Speaker" 293
Chestnut-backed Wren 385
Black-crested Antshrike 393

MY TROPICAL AIR CASTLE

CHAPTER I

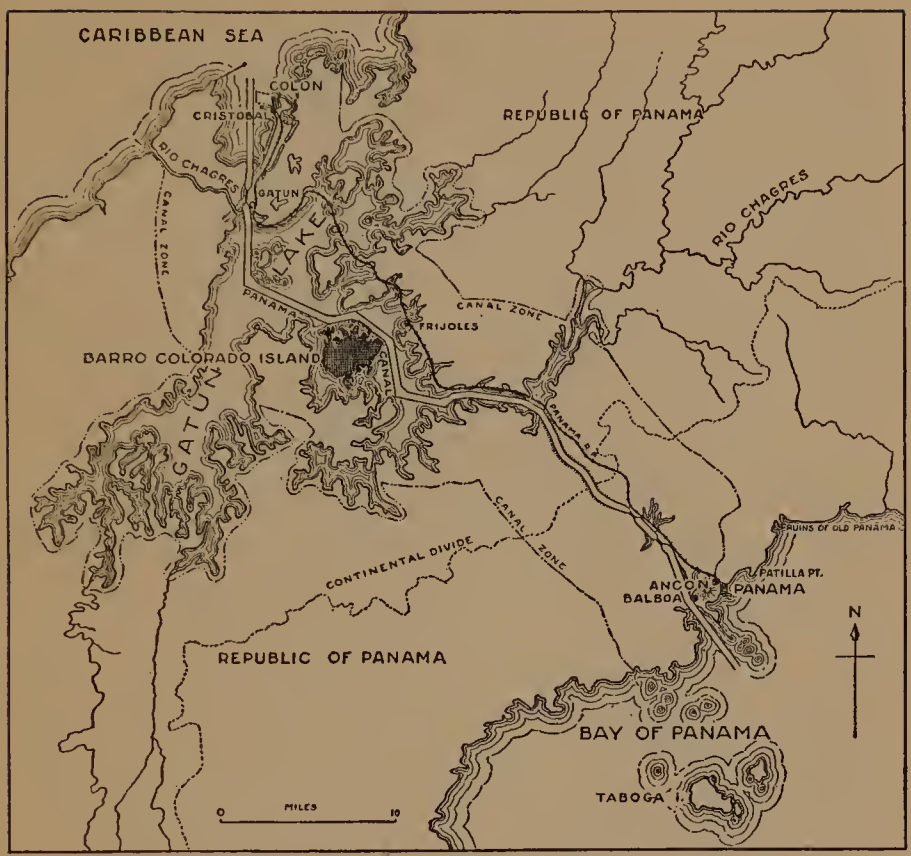
BARRO COLORADO

In the construction of the Panama Canal, when Gatun Dam was finally closed, the waters of the Chagres River rose eighty-odd feet, flooded 165 square miles of lowlands and made islands of the hilltops. The largest of these islands is Barro Colorado. It is situated about midway between the Caribbean and Pacific, is roughly circular in shape, with a diameter of about three miles, an area of 3,840 acres, and an altitude of 452 feet above the lake. With the exception of a few acres, it is forested from end to end and bottom to top. Here is the home of the Institute for Research in Tropical America, a branch of our Government's National Research Council. Here properly accredited scientists will find comfortable living quarters and facilities for the prosecution of their studies both in the forest and in the laboratory.

The damming of the Chagres made Barro Colorado an island but it did not make it an island laboratory; for the steps that have insured its preservation and

made its resources accessible to students, we have to thank the gentlemen to whom this book is dedicated. It was their vision that induced Governor Jay J. Morrow, in April, 1923, to designate the island a reservation for the conservation and study of its flora and fauna under the care and direction of the Institute just mentioned. It is due to their judgment and energy that these ends have been so effectively advanced. In its short history the island has been visited by specialists in many branches of biology—botanists, entomologists, herpetologists, ornithologists and mammalogists. Many of them have had wide field experience in other parts of the world and all alike testify with enthusiasm to the luxuriance of the island's life and to the ideal conditions under which it may be studied.

The life of Barro Colorado is primeval. We can see the trees and plants and it is said that they may number a thousand species. Over 230 species of birds have been observed and either through observation or automatic flashlight photographs we know that the list of mammals is essentially complete. Puma, Ocelot, Baird's Tapir, Collared and White-lipped Peccaries, White-tailed and Forest Deer, or Brocket, four species of Monkeys, two of Sloths, the Tamandua, Tayra and Agouti all, by their presence, bear witness to the completeness of our fauna. Only



The Canal Zone and Barro Colorado

the Jaguar is missing from the recorded species of the larger forest mammalia, and it possibly may occur. If other forest-inhabiting groups are as well represented we may regard Barro Colorado as an essentially complete faunal unit—a little world in itself. Herein lies its inestimable value to the ecologist—he who studies the relation of an animal to its environment, both physical and organic. For it is obvious that, if we would learn the part that any

animal plays in the drama of life, we must ask that the setting be undisturbed and all its fellow actors be present. The extinction of an existing species or the introduction of a new one might radically disrupt conditions now existing on Barro Colorado. If, for example, all the cecropias should suffer the fate of our chestnuts, the Three-toed Sloths that seem to feed exclusively on their leaves would presumably follow them; and who could predict the disaster that would follow the introduction of the Mongoose? Furthermore, in problems concerning structure, color and habits, we have the indispensable advantage of studying an animal in the surroundings to which, during the course of its evolution, it has become adapted. Change the surroundings and you alter or destroy factors and conditions which are essential to the solution of the problem. The dead trees of Gatun Lake are not the haunts in which to study the color of a Parrot in relation to its habitat.

The value of Barro Colorado as a natural laboratory has been enormously increased by its insulation. No other barrier could have segregated it as effectively as water; none could have given it a more definite individuality.

To exactly what extent the island played the rôle of Ark as the lowlands were flooded it is impossible to say. There is a belief current in the Canal Zone

Barro Colorado and Gatun Lake from an Altitude of between 11,500 and 12,000 Feet

1. The Laboratory Clearing *2. Termite House* *3. Redwood House*
4. Fairchild Point, the probable camp-site of Capt. Luis de Castillo in 1670. The Canal passes between this point and the one opposite.
5. Monte Lirio on the Panama Railroad *6. Gatun* *7. Cristobal* *8. Mouth of Chagres River*
(Photographed June 20, 1927, by U. S. Army, Air Service, France Field, Canal Zone. Courtesy U. S. Army, Air Service.)

The Clearing and Buildings of the Institute for Research in Tropical America
(*Photographed March 9, 1927, by U. S. Army, Air Service, France Field, Canal Zone. Courtesy U. S. Army, Air Service.*)

that many of the larger mammals now on the island sought refuge there when their former haunts were submerged. At one time I shared this view, but further study of the subject convinces me that it is not tenable. Gatun Lake was not flooded by an inundation. The dam was closed gradually, from level to level, during a period of four years. As, from time to time, the waters slowly rose, animals forced to leave their homes had abundant opportunity to retreat to new ones. The land submerged compared with the area surrounding it is insignificant in extent and even if Barro Colorado received its full share of refugees the number could not have been large.

While, therefore, it is not probable that the flooding of the Chagres Valley materially increased the mammalian life of Barro Colorado it seems clear that the resulting insulation and, later, the protection afforded by the Institute for Research, have been favorable for its increase. To what extent can this increase continue? Does the island already hold as many vertebrates as it can support? If the existing fauna is balanced will not eventually some species become unduly abundant? Is the island large enough to possess and support reserves of life which may be drawn on to maintain a balanced fauna? These are some of the questions we ask ourselves. They are of more than local importance; they are of wide vital

significance in the study of animal life at large. And if the circumscribed conditions which prevail on Barro Colorado enable us to answer them, we shall have made an important contribution to our knowledge of those causes that determine the comparative numbers of species, and lead to their success or failure.

In considering this question it should be remembered that nearly 4,000 acres of tropical forest, at least half of which is mature, will support a far larger fauna than the same extent of Temperate Zone woodland. Not only does it afford cover throughout the year but the density of the vegetation gives opportunities for concealment such as a northern forest rarely offers. Arboreal species have a world of their own in the aërial gardens of the tall, heavily-limbed, parasite-covered trees. Furthermore, there is comparatively little level ground on Barro Colorado. Its sides are seamed by deep drainage ravines, or barrancas, in which vegetation flourishes with exceptional luxuriance throughout the year. Its mere superficial expanse, therefore, gives no more idea of its possibilities for habitation than the ground-area occupied by a tenement house tells of the swarming life within. In short, if some cosmic rolling-pin should reduce Barro Colorado to the flatness of a pancake its acreage would doubtless be more than doubled.

It is also of importance to know whether the island's life is completely or only partially isolated from that of the mainland. On the northern shore, Fairchild, the nearest of two projecting points, is within 500 yards of the opposite shore. The canal, following the former course of the Chagres River, passes through the intervening space. Here, in the pre-canal period, the river evidently washed the shores of Barro Colorado. It was probably on this point that, in 1670, Captain Luis de Castillo, Commander of the Spanish forces sent from Panama to oppose the advance of Morgan, established his outpost. But before the boats bearing Morgan's men appeared, the Spaniards retreated, leaving a record for valorous discretion and of the earliest application of the name Barro Colorado to the red clay promontory they had occupied.

On the southern side of the island, a peninsula to the eastward of the terminus of the Zetek Trail extends to within 250 yards of one projecting from the mainland. This is the nearest approach of the two land areas. The intervening waters are comparatively shallow and cover the former divide between the Rio Trinidad and Rio Gigante drainage. If Barro Colorado should ever become joined to the mainland I should expect the connection to occur at this point.

Mammals not averse to water might readily swim here from shore to shore. Hunting is prohibited on the island but occurs on the mainland. So far as safety is concerned there is consequently no reason for leaving the island and every reason for coming to it. Predacious animals find protection and an abundant food-supply on Barro Colorado. The fact, however, that the predator as well as his prey is common indicates that there has been no extensive interchange of terrestrial mammals between the island and the neighboring shores.

Of birds we may speak with more confidence. Barring a few nocturnal species, their movements can be readily observed, and, with the exception of wide-flying forms or those that inhabit the open, it is doubtful if the island either gives or receives life.

For example, to birds like Pigeons and Parrots that make long flights between their sleeping- and feeding-places, and Buzzards, Hawks, and Swallows, and some Flycatchers that hunt their prey on the wing in the open, Barro Colorado is in no sense insulated. It is worthy of note that those species in which the individual has a wide daily range are distributed over a large area. Thus, among Barro Colorado birds the Scaled Pigeon is found from Mexico to southern Brazil; the Plain-colored Parrot from Panama to Peru; the Blue-headed Parrot from

Costa Rica to Argentina; the Turkey Buzzard from Patagonia to Canada; the Gray-breasted Martin from Mexico to Bolivia.

On the other hand, the Tinamous, Curassows, Guans, Motmots, Trogons, Toucans, Puffbirds, Antbirds, Woodcreepers (*Dendrocolaptidæ*), many Flycatchers, Manakins, some Wrens, Vireos, Warblers and Tanagers are confined to the forests, and their ranges, as spccies or races, are comparatively restricted. With the exception of some migrating Kingbirds I have never seen a member of one of these groups pass between the island and the mainland. Since, therefore, our avifauna is largely composed of sedentary, forest-inhabiting species, it is not probable that it is affected by intrusions from off the island. When the forest is felled these birds disappear and are replaced by the species of the open. The appearance of Anis, small Finches, certain Tanagers, and other birds of the arid or semi-arid tropics in our clearing illustrates this fact.

Lacking definite knowledge of the life of Barro Colorado in the pre-canal period, or indeed prior to the establishment of the laboratory in 1923, we are unable to compare the present with the past. Dr. Herbert Clark, Director of the Gorgas Memorial Laboratory, and for many years a resident of the Zone, tells me that Barro Colorado was long a

favorite hunting-ground of local sportsmen among whom it was noted as a resort of 'cats,' a fact that goes far to explain the numbers of Pumas on the island today.

The insulation of Barro Colorado has given it a shoreline of 42.85 miles, and thereby has increased the area favorable for the occupation of such littoral animals as Iguanas and Basilisks. It should be remembered, however, that the shores of the Chagres River and of other drowned streams must have supported large numbers of these lizards. They, therefore, doubtless supplied abundant food for Pumas, Ocelots, and Coatis in pre-island days. If, however, insulation has not materially increased this source of food, it has done much to concentrate it and make it more readily available to the animals that inhabit the slopes of Barro Colorado.

In 1923, when the island was placed under the care of the Institute for Research, there were four settlers at separated points on its shores who, together, had about thirty acres under cultivation. Their holdings were at once purchased and are now overgrown with impenetrable scrub. It is not probable that their presence has permanently affected the fauna.

On the other hand, in the clearing about the laboratory there are numbers of species of birds unknown in the forests. Aside from these obvious effects

of insulation and human occupation, we are not yet sufficiently familiar with the fauna of the island to determine with certainty whether any changes have occurred in it during what may be termed the historic period. General impressions based on casual observations are not, as a rule, trustworthy. As animals become more accustomed to the presence of man and learn that he is not to be feared, we are apt to see them more frequently and hence conclude that they are more abundant. It will take close, expert observation, extending over a period of years, to make, for example, even an approximately accurate estimate of our large mammal population; by which I mean those species from the size of an Agouti upward. Until this is done we will not be prepared to recognize fluctuations in their numbers. The fact, however, that it may be done is evidence of the exceptional advantages that Barro Colorado offers for extensive field-work. In the succeeding pages I have tried to make some contributions to this subject and I will not anticipate them here.

But the desirability of Barro Colorado as a station for the study of tropical life extends far beyond the fact that it possesses a practically primeval, insulated flora and fauna. In the first place it has an excellent climate. The annual precipitation is not excessive (about 130 inches) and sufficient rain falls during the

dry season (December 15–January 1 to April 15–May 1) to keep the vegetation in large part fresh and green. The daily range of temperature averages fifteen to eighteen degrees (from 70°–72° to 85°–88°). During the dry season, at least, this mild heat is so tempered by the trade winds that, unless one is exercising, he is always comfortably cool.

Barro Colorado is healthful. Malaria is unknown on the island; there are comparatively few really troublesome insect pests; rain-water from a corrugated iron roof is used for drinking purposes. In the event of illness or accident, one has the assurance of adequate attention at the Gorgas Hospital in Ancon. To this, as well as to other institutions in the Zone and in Panama, workers on Barro Colorado may also look for coöperation in their researches.

Barro Colorado is comfortable. Living conditions at the laboratory so nearly approach the luxurious that one constantly feels in an apologetic frame of mind toward those naturalists who, to reach primeval surroundings, have gone farther, fared worse, and seen less. One finds, for example, no descriptions of the abundance of tropical wild life in Nicaragua and Amazonia in the works of Belt, Bates, and Wallace that compare with our almost daily experiences. In the main laboratory building there are large tables, abundant storage-space, drying-rooms, a darkroom,

laboratory supplies, airy sleeping-quarters, and a shower-bath. Food and ice arrive at short intervals from the Government commissary, and the culinary department is always effectively, if simply, served.

Barro Colorado is accessible. Steamers from every land dock at the canal ports of Cristobal and Balboa. Cristobal may be reached in six days from New York and four from New Orleans. Balboa is distant nine days from Los Angeles. From either end of the Canal one may arrive at the laboratory after an hour on the railway to Frijoles and thence a half an hour on a launch.

Barro Colorado makes an admirable base from which to reach the adjoining highly diversified areas. Most students have found the life of the island inexhaustible, but for those whose work or interests call for a wider field, or who require material or experiences for comparison, it makes a convenient point of departure.

Gatun Lake, with hundreds of miles of shoreline and many inflowing streams, offers a limitless region for exploration by launch or cayuca. The mainland surrounds us; westward it leads to the higher altitudes with distinct zonal faunas in Chiriqui and Costa Rica; eastward, to still unknown territory in Darien. To the north lies the Caribbean, to the south the Pacific, separated by a continent here less

than fifty miles in width. From Cristobal one may reach the San Blas country within a few hours or, within a day, be on the slopes of Irazu in Costa Riea bound for Temperate Zone levels.

From the City of Panama motor roads now extend to the western part of the republic and also through an interesting country to the eastward. It is probable that within two or three years the Isthmus can be crossed by motor.

From Balboa one may embark for the islands of Panama Bay with their bird eolonies and nearby fisheries, or for the Tuyra River.

Barro Colorado is not a publie park, playground, or resort for tourists. The Zone mainland and adjaeent areas offer wide opportunity for outdoor recreation, hunting, and exploration. The island is designed not alone to conserve life but to maintain conditions where, undisturbed, researehes may be conducted throughout a season or over a period of years. The laboratory is always open and investigators may come at the time most convenient for themselves or most favorable for their studies.

Winter or summer, dry season or wet, one will usually find kindred spirits on the island whose investigations, though in a different field, may have some bearing on his own, and whose special knowledge will add to his sources of information.

What has the Institute done during its short history to justify the faith of the Canal Zone authorities in placing this island in its charge?

Primarily it has acted as a guardian of the island's flora and fauna by halting the destruction of its forests and preventing the killing of its animal life. Assured of the preservation of those primeval conditions which constitute Barro Colorado's chief value as a natural laboratory, the Institute has established a home and working quarters where students may live comfortably and work effectively. From colleges, museums, and botanic gardens throughout the United States and in Canada, naturalists have come to Barro Colorado to avail themselves of opportunities and facilities which can be found only there. Their researches include Allee's measurements of the physical factors of environment—temperature, humidity, evaporation, light-intensity, a paper of fundamental importance, and the same author's essay on the relation between these factors and the distribution of life in a tropical rain-forest (*Ecology*, 1926). In a similar field is Kenoyer's 'General and Successional Ecology of the Lower Tropical Rainforest' (*Ecology*, 1929). It gives an informing summary of climatic conditions, an analysis of the characteristics of the forest, and a statement of the order of growth by which a clearing is reforested and

marshes formed. Its author estimates that 1,000 species of vascular plants inhabit the island.

Other representative investigations in botany are Standley's studies published as *The Flora of Barro Colorado* (1927) and subsequently embraced in his *Flora of the Canal Zone* (1928), a volume of 400 pages; and Weston's detailed studies of aquatic fungi and fresh-water algæ, made from October, 1928, to May, 1929.

Illustrating the close relation between laboratory and field-work are Kirby's studies of the protozoan fauna of the intestinal tract of termites, in other words, the digestive apparatus of these wood-devourers; and Zetek and Snyder's tests to discover kinds of woods and methods of treatment which will withstand the attacks of these destructive creatures. The individual experiments in this investigation, which is the most extensive that has thus far been made, now number over 200 and range in size from a shingle to an entire house.

Zoölogical researches include Baerg's studies of the venom of spiders, centipedes, and scorpions; Wheeler's work on social insects; Rau's on the psychology of wasps; Lutz's on stingless bees and leaf-cutting ants and Curran's on Diptera. Dunn, Gaige, and Schmidt have added greatly to existing knowledge concerning the habits of the frogs and

reptiles found on the island. In birds, Gross has studied the nesting-habits of the Purple Gallinule, Massena Trogon, and other species; Van Tyne has monographed the Short-keeled Toucan; Chapman, Wagler's Oropéndola; and Sturgis' *Birds of the Panama Canal Zone* is in part based on studies made on Barro Colorado.

Sloths and Monkeys have supplied Richter and Wisslocki with material for studies in mammalian physiology, and, it is hoped that the present volume shows that the island offers an exceptional field for acquiring an intimate knowledge of the life-histories of mammals.

Popular writers on natural-history subjects have also come to Barro Colorado for original material and, through the medium of magazine articles, the fame of the island and its life has been made known to thousands who were previously unaware of its existence.

Information concerning tropical life, as it exists in the Canal Zone, has also been disseminated through addresses in classroom and lecture hall by visitors to Barro Colorado who, whether or not they have gone there for research, have found inspiration in the beauty of the island and the wealth of its flora and fauna. I have seen even a few days in the forest of Barro Colorado mentally rejuvenate teachers who

for years had been repeating other men's ideas and observations in a treadmill of unconvincing lectures. Countless objects and facts which they knew before only from books, now became their own personal possessions, and they went back to their classes, not to repeat what they had read, but to describe what they had seen.

A darkroom in the laboratory, running water, and an unfailing supply of ice, encourage every form of photography, and countless negatives and thousands of feet of motion-picture film have helped to convey graphic information concerning the exhaustless natural-history resources of the island.

The studies for the habitat group of tropical American forest birds, exhibited in The American Museum of Natural History, were made on Barro Colorado, and the actual trees and vines used in the group came from the island. Groups representing other phases of the island's life are planned, and thus museum exhibitions will become an added means of reaching an audience which will see in them not merely a museum exhibit, but a scene from the only bit of continental tropics under our flag.

As the laboratory of the Institute for Research in Tropical America, Barro Colorado is on the threshold of what should become an increasingly important existence. As the years pass and an ever-

growing number of students seek to avail themselves of its resources, it is hoped that those responsible for its policy will never for a moment forget the importance of maintaining those primeval conditions which, as the island's chief asset, make this by-product of the Panama Canal a unique national possession.

CHAPTER II

CASA MIA

THE only stone that I may claim to have placed in the foundation of this island air castle is a little dwelling which I call my own. On my first visit to Barro Colorado I occupied quarters provided by the Laboratory and was eminently comfortable. But I knew that I should feel more nearly a part of the fauna if I could have a shelter which was as distinctively mine as the nests of the Oropéndolas are theirs. Then I should always be assured of a home to which I could return in mind as well as in body—and there are few days in the year when I do not visit it mentally.

It has, I think, already been shown that no small part of Barro Colorado's attraction is due to the comfort with which one may live there. This attempt to share the pleasures of an ideal experience may therefore be further prefaced and, I hope, advanced, by a description of my home and its setting. As its designer I at once confess that in external appearance it is not in harmony with its surroundings. A palm-thatched bungalow would be

Howling Monkeys Feeding

They are eating the buds and new leaves of a tree above the author's house which they frequent annually at this period of its development. (*See page 46.*)

Trapping a Robber

The Sandbox Tree

This tree, which grew near the laboratory, was the home of the Oropéndolas whose nests may be seen hanging from its upper branches. It fell before a storm on August 28, 1928, and was found to measure 132 feet in length. (*See page 61.*)

more in the spirit of the place. I rccall one that I once occupied in the island of Trinidad. On the walls of my room there I counted sixteen spiders having a diameter of about six inches each; lizards chased cockroaches with a startling rush and rustle in the interstices of the leafy ceiling; occasionally a snake found its prcy there; and by day it sheltered bats.

It was all very interesting, and the activities of these creatures furnished me much amusement during an illness when I had nothing to do but lie on my back and watch them. But the house was not the kind of a dwelling one would select for a prolonged stay. Here I have a home which, with deliberate inhospitality, is designed to exclude every form of life except man. Outside everything is welcome; but I draw the line at my threshold, and only the minute insects that at night pass through my screens succeed in crossing it. This is my home, and I want it exclusively, just as much as any animal wants his. If I should open my screens to every creature that knocks on them I should soon be overwhelmed by visitors. Any native of the island may, if he likes, look in and study my habits during my periods of self-imposed captivity, and I sometimes feel that I am an object of no small interest to Bats, Coatis, Monkeys, Trogons, Toucans, and other beasts and

birds that live in the adjoining forest. I encourage these investigations and intimacies. The more the native inhabitants know about me the better friends we shall be, for my intentions are above suspicion.

In some cases this habitation of mine appears to have been accepted as a natural part of the environment. The Goatsucker (*Nyctidromus*) that sings in my clearing catches insects on the screens of my verandah, and this morning sprang fifteen feet straight up from the ground to snap a moth off the netting an arm's length from where I stood. A Panama House Wren goes to bed regularly at 6 o'clock beneath my eaves, which also shelter numbers of Bats. Indeed, I keep a feeding-table for Bats on my porch-railing. Bananas are their favorite fare. They eat them on the wing, taking a bite as they pass and rarely pausing more than a second. In an orderly way one follows the others, as though he were waiting his turn. I have never seen two feeding at the same time. They are gentle, quiet, well-mannered guests.

For several nights I was awakened by stealthy footsteps on my stairs. I could feel a slight vibration. After a moment a hand was drawn across the window-screen of my dressing-room. Having only just come from the land of the lawless, of second-story men and the like, where listening for just this kind

of sound has become second nature, it required a moment or two to convince me that my nocturnal caller was a Coati, doubtless attracted by the odor of a ripe banana. To prove the correctness of my identification I set a camera-trap on my steps. In some mysterious manner he succeeded in passing the trip-wire on the way up, but I caught him making off with his booty on the way down.

Nominally, a house of but two rooms, each 12 feet square, this model abode contains, in addition, a screened verandah 6 feet wide by 24 feet long, and since it is built on piers 7½ feet high, there is a ground-floor 18 by 24 feet. Thus, in effect, I have five rooms, each one serving its own special purpose.

The first is the porch on the leeward or forest side. Furnished with a seat, it forms a disrobing chamber where one may divest himself of muddy shoes and garments which may harbor a tick or two and, in any event, should be hung on the porch-railing to dry. Thence one enters the dressing- and storeroom from which a doorless doorway at the right leads to the study and bedroom. One side of each room is supplied with shelves from floor to ceiling. Here are arranged (at the beginning of the season in perfect order) equipment, supplies, clothing, books, etc. There are no drawers for there is no dust; everything is in sight, or should be, and any article desired may

be found at a glance. There are no carpets or rugs to serve as hiding-places for unbidden guests or exercising-fields for reiterant carpet-sweepers. Their place is taken by an abundance of bath-slippers. Overhead the ceiling is of celotex, a nonconducting material, with screened openings leading to the 'attic' which, in turn, has screened apertures in each gable.

The three remaining sides of each room are occupied largely by windows (screened and glassless) and the door to the verandah. Here swings a Yucatan hammock which may be occupied by day or by night. It forms a wholly admirable place from which to listen to the morning bird-chorus and see through the forest the first rays of the sun change the lake from gray to gold. This leaves us with the ground-floor, really the most important part of the house. Here, as from a tower, one may look toward every point of the compass. There is no screen to obstruct the view or shut out the air. Even when our flag hangs limp down its pole, it is cool here and always there is shade. This is my look-out station. A 24-power binocular, mounted on a tripod, reveals the identity of almost every bird near enough to be seen with the unaided eye; and when I care to venture to the edge of the world I use it to read the name of a passing steamer.

For my purposes this little dwelling is perfect to the uttermost detail. I will agree that there are finer and possibly more comfortable edifices in the world, but not for one moment will I admit that there is one more marvelously situated. This assertion I am prepared to defend with an overwhelming variety of evidence.

When Raymond Shannon, the first naturalist to visit Barro Colorado, sought a camp-site whence he might pursue his studies of mosquitoes, he selected for his landing-place a cove with two inflowing streams. Here, in the forest, on a small shelf of level ground, some thirty feet above the lake, he built a little shelter. Two years later, when Barro Colorado was definitely set apart as a reservation for the conservation and study of tropical life, it was found that 'Shannon's Shack' was placed at the foot of a promontory which afforded an ideal site for the laboratory and its small buildings. A V-shaped clearing, with arms leading to the water and the base just back of the laboratory, was made in the forest. The ground was planted with bananas, papayas, plantains, oranges, mangoes, and other fruit-bearing trees, and a flight of 196 steps was built up the steep slope from the pier to the laboratory, 115 feet above the water.

The crest of the promontory suggests the bow of

a great ship, and the laboratory is placed at the foot of an imaginary bowsprit. Our 'course' is due northeast, and we look out over the lake, here from one to two miles in width, to a forested shore whose outline is broken and indented by the mouths of creeks and little lagoons. The ground beyond quickly rises in low hills, and behind these are others, range after range, each higher than those before it until they reach the dignity of mountains, and I know them for part of the Andean system that forms the backbone of Panama.

Except for a banana plantation or two near the water, this widespreading landscape is covered with trees. In the foreground they present an infinite variety of greens, marked in March with the far-carrying, golden yellow bloom of the guayacan.[1] I have counted over two hundred of these glowing spots from my house. From this definiteness of outline and color the landscape gradually merges with the hazy, always cloud-hung horizon.

It is in late December and early January, when the dry season is struggling for control, and the days are a succession of strongly contrasted and abruptly changing meteorological conditions, that the view across the lake presents its greatest interest. Over a blue sky clouds gather quickly; the lake becomes

[1] *Tabebuia guayacan.*

gray, squalls play on its surface; and suddenly the rain is on us. The Howling Monkeys roar a protest but their voices are literally drowned by the sound of the increasing storm. The lake becomes invisible; the world itself seems obliterated by walls of falling water. Then, quickly as it came, it passes; a bit of blue sky appears; the sun, like a searchlight, sends down brilliant streaming rays and soon floods the earth with golden cheerfulness. Again the vault is azure; great mountains of fluffy white clouds are banked on the horizon and the soggy earth and dripping, glossy, spangled leaves are the only evidence of the storm. In a few minutes it may be raining again, and this rapid shifting of the scenes between the two extremes creates a constantly changing panorama of great beauty. One morning a vivid bow faced the rising sun and through its center a Man-o'-War Bird, on set wing, sailed majestically.

The lake itself, a mirror in the calm of early morning, is crisped with white-caps by the trade winds of the afternoon. Always it affords the strange setting of a small body of mountain-surrounded water through which pass ships of the Seven Seas. Sooner or later every type of ocean-going vessel, whether of peace or war, crosses this water-bridge. There are small local craft, native dugouts or cayucas with a hand's-breadth of sail, launches towing banana-laden

barges, and Government patrol boats. Three days ago, four aviators, who were not only men-birds but bird-men, dropped down in hydroplanes for a conference on matters ornithological.

Bound to foreign ports, near and far, are tankers and freighters, nondescript sea-worn tramps, passenger steamers, and, rarely, a sailing vessel under tow. During the tourist season, flag-bedecked ocean liners make the transit. They may be going around the Horn or around the world, but nowhere will they find another Barro Colorado.

On January 25, 1927, there is an entry in my journal that bears witness to the strange associations which are so characteristic of life in Panama. It reads:

"On this day several Coatis, a band of Collared Peccaries, a family of Howling Monkeys, and the Duke and Duchess of York passed my door." The first two were on land, the third was in the tree-tops, and the last-named were on H. M. S. *Renown*. Very beautiful and stately it looked as, unattended and noiselessly, it emerged from the trees on one side of the lake and quickly entered them on the other.

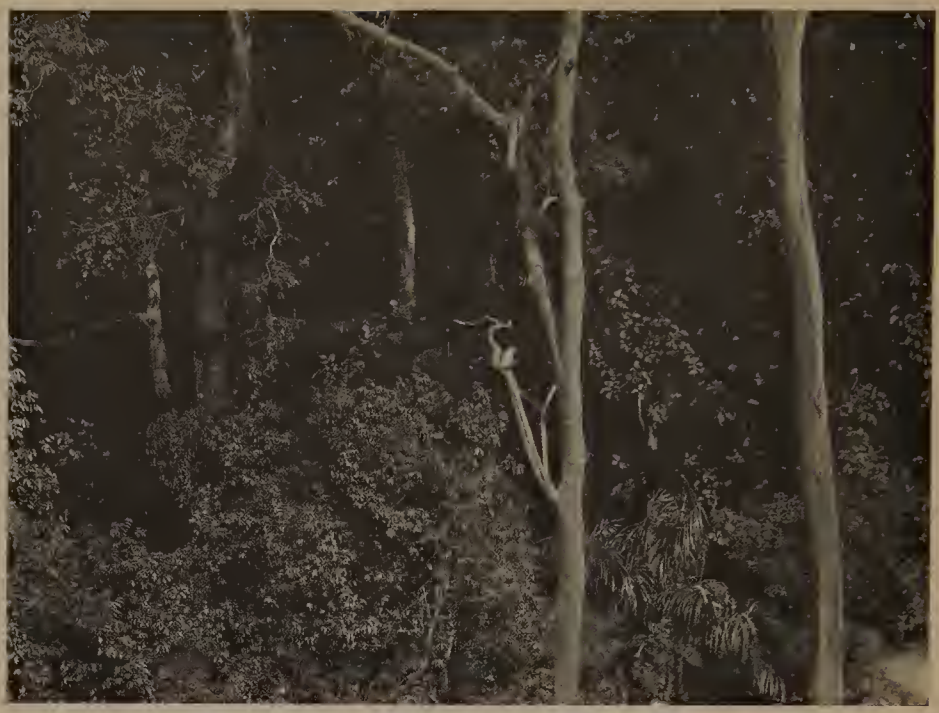
It is when our own fleet goes through the canal that one is most impressed by the significance of this waterway. As vessel after vessel passes, from pygmy submarine to giant battleship, I invariably think of

The Laboratory from the Lake

It is 115 feet above the lake and reached by a flight of 196 steps

The Lake from the Laboratory

The steamer is distant a mile



The Forest at the Eastern Border of the Clearing

A snowy-plumaged Ghiesbrecht's Hawk occupies its favorite perch. (*See page 30.*)

Ghiesbrecht's Hawk

Captured with a camera-trap set in the bed of a brook and baited with a fish-head
(*See page 61.*)

the man whose courage and foresight made their passage possible. How Roosevelt would have enjoyed Barro Colorado!

There are not many birds in the lake. It was hoped that the migrant Ducks from the north which visit these latitudes would find sanctuary here. But this is an artificial body of water. Man has made a lake but he has not supplied it with food such as Ducks require. The mere presence of water is not enough; nor are there suitable haunts where shore-birds might feed.

Cormorants are not uncommon in flocks of a hundred or more and evidently find good fishing. Laughing Gulls follow the steamers and are thus transferred from ocean to ocean. Occasionally I see Brown Pelicans and Man-o'-War Birds. Yesterday, twenty-one Pelicans, in perfect V-formation, flew north, models of ease, precision, and *noiselessness* for the aviators at France Field. I do not see Man-o'-War Birds in such large numbers. Usually only one or two pass over. Rarely, both these species fly low enough to feed in the lake, and on one such occasion I saw a Man-o'-War Bird vigorously pursued by a Kingbird.[1] Possibly it was a first meeting for both of them.

As a rule, both Pelicans and Man-o'-War Birds

[1] *Tyrannus melancholicus chloronotus.*

cross the Isthmus on a non-stop flight and at so great an altitude that the transcontinental journey was apparently planned before starting. On what experience do they base this aërial voyage? Can they, when at an altitude, see from ocean to ocean? Have they learned the way since Atlantic and Pacific were connected by man, or do they inherit a knowledge of the route from ancestors who followed it when the two seas were last joined by nature?

Sunrise from our promontory is a glorious promise each golden day fulfils. The sun does not come suddenly, glaringly, blinding you as it slips from behind the mountains, but, screened by the forest, we first see it change the gray waters of the lake to burnished copper and paint a picture on the shifting panorama of the clouds. The rise of the full moon marks the scenic climax of each month. I cannot describe this miracle of light on the lake and shadow in the forest.

So much for the view ahead; now let us look over the sides of our imaginary prow. Both to right and left the ground drops sharply, but on the right it continues to fall after the border of the forest is reached. Beyond the foreground slope of bananas and papayas one looks, therefore, directly through great, columnar trunks into the cave-like recesses of the forest. Growing from over a hundred feet below

us, the tops of some of the trees are but little above our level, and we have an excellent opportunity to see the birds and mammals that visit them.

At the left the ground slopes with equal abruptness at an angle of about 45°, but here, when we reach the brook at the base of the forest wall, the opposite shore rises and our view is of the roof of the forest. Like a vast garden it spreads before us an endless variety of leaf-form and a surprising display of bloom, as, with the advance of the dry season, certain trees become masses of color, not mere dabs of the brush here and there, but laid on with a liberal hand to form a strong note in the picture. In January, when the soft creamy white of the laurel[1] turns to brown, it is followed by the rich pink of the madroño.[2] This in turn gives way to the scarlet of the palo santo,[3] or holy tree, and the gold of the guayacan[4]; and, as the rainy season approaches, this carnival of inflorescence is closed by the rose-pink of the roble[5] and royal purple of the jacaranda.[6]

Two hundred feet in the rear, over our little garden of ever-flowering scarlet hibiscus, native orchids, and ornamental plants, essentially primeval forest bounds the end of our clearing. Within its shadow, on the only available site, is placed my house. At my feet

[1] *Cordia aliodora.*
[2] *Macronomum glabrescens.*
[3] *Triplaris americana.*
[4] *Tabebuia guayacan.*
[5] *Tabebuia pentaphylla.*
[6] *Jacaranda* sp.

lies the lake with the wooded hills and mountains beyond; turning my head I look up the trail, that begins at my doorstep, into the depths of the forest. Where, from the same standpoint, can one find two more perfect, more strongly contrasted views? Where will one find a human abode in the tropics so admirably placed for the comfort of man and the needs of a naturalist? If I had planned to build an observation-blind I could not have chosen a better site. But this is a blind which is also a home and it can be occupied by night as well as by day. From the moment when, with clock-like regularity, the Motmots announce the beginning of day, until at dusk a Crocodile noses a spreading V across the waters of our cove, there is no time when the attention of eye or ear is not claimed by passing events. And the night has a story of its own.

Even though I am only a winter migrant from the north, the regularity of my occurrence and the permanency of my abode give me a feeling of being on neighborly terms with the indigenes. When, for example, I came back to my house this year, Howling Monkeys were eating the new leaves in a tree above it. They seemed to be taking my leaves and thus were my guests. The Coatis, which for days have been feeding in the branches of a nearby almendro, do so with the assurance of visitors who are welcome; and

when, year after year, the Oropéndolas returned to their roof-tree shortly after I returned to mine, they seemed like friends of long standing.

It is not alone what I find here but what I leave behind that increases my affection for Barro Colorado. This is an age of noise and confusion. Consciously or unconsciously we react to the atmosphere of unrest in which we live. We rarely experience either absolute silence or complete solitude. We are always under tension; our very bodies seem motor-ridden; our ears roar with the turmoil of life. Automobiles bid fair to overwhelm us. The radio, phonograph, and telephone leave us no privacy. But these so-called "blessings" which, uncontrolled, become a curse, are unknown on Barro Colorado. The only automobiles I have seen from the island were lashed to the deck of a submarine going through the canal! Here, for eye and ear alike, every prospect pleases, and as we are the only men, we have only ourselves to blame if the world is not to our liking.

CHAPTER III

IN AND ABOUT THE CLEARING

EACH year I delude myself with the belief that in the seclusion and quiet of my home on Barro Colorado I will be wholly undisturbed, and each year I discover that I am subject to more interruptions here than I am at my desk in the American Museum. At this moment (March 15, 1928) I have retreated to my study to shut out as much of the outside world as may be, but two Palm Tanagers are conversing on a limb just outside my window, an Oropéndola is taking something from the vase-like flower of a balsa just beyond them, and the appearance of a small unrecognized Flycatcher sends me hurriedly for a glass with which I try in vain to determine his identity. I might close my blinds or face my desk to the wall, but there would still come the voices of many friends and some strangers, each with its message or its lure. Or Donato may call me to see something he knows is of exceptional interest. Yesterday it was an Iguana between five and six feet long which had crawled beneath the guest-house, presumably to lay its eggs. Animated by the spirit that prompts

us to pursue anything that moves, and perhaps also by the thought of fresh, boiled Iguana eggs (a local delicacy), several of us surrounded the building, but when the formidable looking creature made a dash for safety there seemed to be a certain lack of organization among its would-be captors and it made its escape. In the end more serious work is usually abandoned, and I frankly yield to the temptation to watch the play of life about me.

In no other part of the island are birds more abundant than they are about the laboratory; nowhere else can they be so readily observed. The clearing gives us a cross-section of the arboreal bird-life of the forest as many species fly across it, perch, feed, or even nest in the trees at its border. The clearing itself, with its open, grass-grown spaces, introduced trees and plants and bushy second-growth, has provided haunts for birds unknown in the forest, thereby increasing the diversity of our fauna and demonstrating that new areas are occupied by forms adapted to them as soon as they become available for settlement. From or near my house, therefore, I have seen or heard about 120 species of birds or, approximately, one-half the number known on the island. With the exception of seven North American migrants, all are permanent residents of the tropics and liable to be seen any day in the year. Aside from

its daily range, temperature in the tropics varies but little throughout the year. The seasons, therefore, are characterized by the distribution of rainfall. North of the equator the wet season, locally known as *invierno*, or winter, lasts usually from the latter part of April to the latter part of December. The intervening period is the dry season, or *verano* (summer). When little or no rain falls in the dry season and it is prolonged, many trees lose their leaves and the country assumes a parched and arid appearance. Under these conditions the differences between the two seasons, in fauna and flora as well as in climate, are pronounced. When, however, the dry season is shorter and is broken by showers, the trees retain their leaves and nature generally presents much the same appearance that it does during the wet season.

The first type of climate prevails, in a measure, on the southern, or Pacific side, of the Isthmus of Panama; the second type, on the northern or Caribbean side, and hence on Barro Colorado. At the Ancon-Balboa Station, on the Pacific side, the annual rainfall averages 69.31 inches, of which 5.21 inches fall from January 1 to May 1, and the rest during the remainder of the year. At the Cristobal-Colon Station, on the Caribbean side, the average annual rainfall is 128.4 inches, of which 11.1 inches

are deposited between January 1 and May 1, or nearly 6 inches more than falls during this period on the Pacific side. The difference does not seem great but it is sufficient to keep the vegetation greener on the northern than on the southern side of the Isthmus.

Some of our trees lose their leaves in the dry season, some in the wet; some fruit in one season, some in the other. The conditions affecting bird-life, therefore, are always much the same. But as yet, neither here, nor elsewhere in the tropics, have there been made series of local observations extending continuously through the year definitely determining the seasons when certain species, and even certain individuals of that species, nest. Some species we know nest only in the wet season, some only in the dry, while others may be found nesting throughout the year. But I very much doubt the statement that a species may have two nesting seasons. It may have two or even three broods in one season; or some individuals of a species may nest at one time, some at another, and the entire period covered may extend throughout the year. But that the same individual should nest, let us say, in May and again in November is opposed to what we know concerning periodicity in the bird's annual cycle.

This, however, is a subject on which it is hoped

studies made at Barro Colorado will throw some light. Meanwhile we know that there are birds nesting, and consequently singing, during every month in the year. From all of which it follows that neither among trees nor birds do we have such a climax of reproductive activity as characterizes the latter part of spring in the Temperate Zone. The coming of day is heralded by no such Dawn Chorus as we have in the north.

From January 1 to March 1 there is a variation of only six minutes in the time of sunrise (6.35 to 6.41). During March there is a further variation of fifteen minutes (6.18 to 6.33). The observations on the beginning of the birds' day given below were made chiefly during the first two months of the year when each species begins to sing at essentially the same time every morning. The first birds were usually heard about thirty minutes before sunrise. In early June, birds near New York City begin to sing about sixty minutes before sunrise. In these figures we have some conception of the comparative length of the birds' dawn in a tropical January and a temperate June.

THE COMING OF DAY

At about 6 o'clock, with a *hip-hip; hip-hip; hip-hip-hooray* the Parauque Goatsucker announces the

coming of day. So exactly do these words fit the rhythm and express the spirit of his call that one might readily imagine he was actually saying them. But the case only too well illustrates the ease with which we may be led astray by putting the words into the mouths of birds. As a matter of fact, *Nyctidromus* is not so much greeting the day as bidding farewell to the night. For a few minutes he will call and feed and then retire to his bed on the leaves at the edge of the forest to await the coming of that narrow margin between day and night which, in the tropics, reduces his time of activity to the minimum.

But it's not what he actually says that is of importance. It's what he seems to say. Doubtless his notes are a challenge or defiance to his rival calling from the clearing near the lake, but to me he is cheering; and what better way is there to welcome the day than with a cheer? I'm grateful to *Nyctidromus* for voicing my feelings. If I should go out on the verandah and give expression to them myself I should doubtless have Donato running up and saying politely "Mande, Señor?"

However, I do go out on the verandah to see if in the half light I can distinguish the caller on the ground almost under my house and not more than fifteen feet away. Occasionally he bounds lightly, noiselessly, into the air, sometimes to the level of

my eye, doubtless to catch a moth. At this distance his voice has a sharp, penetrating quality that strikes the ear harshly. So many birds' notes are almost unbearably loud at short range. The voice of a Western Meadowlark that perched on my umbrella-blind on the plains in Nebraska, and sang within a few inches of my ear, was so piercing in its sharpness and volume that I shrank from it as one would from a blow. Heard at a distance the song of this bird is rich, mellow, and musical.

Two Owls are also bidding their day "good night" with a loud, resounding *woof-woof-woof* as though they struck the head of an empty barrel with a wooden mallet. They answer each other with perfect regularity, using different-sized barrels. I hear this note nearly every morning at daybreak but have never seen the birds that make it.[1] I imagine them to be as large as Great Horned Owls with serious, solemn faces and a dignity of manner in keeping with their voice.

Rapidly beating his wings in short flights, a Guan or Pavo joins the Owls in drumming and adds a roll to their thump. As a vocalist he may be heard at almost any hour of the day but he rarely drums after sunrise. He doubtless gets his effects with the aid of his sharply incised primaries.

[1] Probably the Spectacled Owl (*Pulsatrix perspicillata*).

To the drummers the morning now adds a fifer—a tropical fifer whose clear, plaintive, crescendo trilling has in it nothing martial, but expresses rather the spirit of peace and the appealing mystery of the forest. This is the Pileated Tinamou that lives at the forest border. There is one so near my house that when his call awakens me he seems almost to be singing in my bedroom. But so closely does he remain under cover that I have yet to see him. The larger, Chestnut-headed Tinamou is more a bird of the evening.

The morning star is still shining when, with muffled hoots, the Rufous Motmots announce their presence. There are high hoots and low hoots, slow hoots and fast ones, with crescendos of rolling hoots. The forest resounds with the soft, pervasive tones. Accompanying them is a loud, harsh, nasal *cah! cah!* at times running off into a *cah; cah-cah; cah-cah-cah; cah-cah* with the pulsing rhythm of a tugboat's engine. It would be difficult to imagine two bird-notes more unlike, but both are made by Motmots, and, singularly enough, the louder sound comes from the smaller species, the Broad-billed Motmot. In ten minutes this singular chorus is over. We may hear occasional *cahs* but rarely a hoot until evening. As a singer the larger species is therefore more crepuscular than diurnal.

At ten minutes after six I can barely see the point of my pencil as from my hammock I write the name "*Xiphorhynchus nanus*," and with such regularity

Rufous Motmot

does this Woodcreeper blow his sturdy whistle that morning after morning his name appears in the same place on my bird-list. A few minutes later the Panama House Wren takes up the musical burden of

his day, and it is by no means a light one. It is still a quarter of an hour before sunrise but with this bird's cheerful notes the day has fairly emerged from the night.

Although but little light can have reached their haunts, Antbirds of several species now call from the lower growth in the forest. The piping of *Formicarius* and *Myrmeciza exsul*, the loud, rail-like whinny of *Myrmeciza longipes*, the plaintive whistle of *Hylopezus*, and quaint, cosy little trill of *Cercomacra* form a very distinctive part of the morning chorus.

Between quarter and half-past six the Oropéndolas summon their wives, in fact or prospect, to their duties in the sandbox tree, and they have not called twice before the Flycatcher, *Legatus*, utters his insistent, endless *pee-ee; tiddle-dee-dee*. There are but few minutes between sunrise and sunset when this bird cannot be heard. If its notes are tiresome to me what must they be to the Oropéndolas to whom they spell disaster? The Cacique also is aroused by the Oropéndola's call and by pure vociferation now dominates the sandbox tree.

Parrots, usually bound for parts unknown, call from the air as they fly over; Paroquets twitter excitedly about possible nesting-sites; Toucans creak and yelp, while Trogons coo. *Pitylus*, the Grosbeak, rings his changing musical phrases from the tree-

tops, where, unseen, the Shrike Vireo calls a monotonous "one-two-three" and to all these voices the low crooning of Cassin's Dove forms a humming background.

The sun is now above the tree-tops. For nearly half an hour the daybreak birds have been silent. The Antbirds and Toucans follow them. As noon approaches, even the Oropéndolas, Colombian Flycatchers, and House Wrens, workers in sunlight, retire and there comes the restful quiet of tropical midday.

THE FOOD TREES

The good fortune which guided the choice of our laboratory site also determined the boundaries of our clearing. If it had been extended another yard or two we should have lost five trees that are a source of food to mammals and birds and of exceptional interest to us. One is ten yards from my verandah; the remaining four face my doorstep. The first is a balsa[1] whose deep, vase-like flowers attract both mammals and birds. The second, still unidentified but related to acacia, stands at the left of the trail entering the forest where it almost overhangs my house. The third, at the right of the trail, bears figs[2] for the Night Monkeys. The fourth, growing so near the fig that monkeys spring from one to the

[1] *Ochroma limonensis.* [2] *Ficus* sp.

other, is a wild nutmeg[1] and immediately behind it is a mangabé.[2] The fruits of the last two are beloved of many birds. So my little house is surrounded on its forest sides by feeding-tables where, with no care from me, a wide variety of fare is offered to both mammals and birds.

To the explorer in tropical America the balsa possesses an interest tinged with the spirit of adventure. Lighter than cork, its wood is used for making rafts, and the name on rivers of Balsapuerto, or "Raftport," usually marks the beginning of raft navigation. Large quantities of balsa wood are now imported into the United States to be used chiefly in the making of life-preservers.

I welcomed this tree as a neighbor for the romance with which it is associated, but I soon found that it was notable not alone for the lightness of its wood. It has beautiful, stately, cream-colored blossoms six inches or more in height that stand upright near the extremity of limbs where they may be seen against the sky. Moreover, these great ivory cups, bound in bronzy sheaths, hold water and a thick liquid exudes from the flower itself. This, with the pistils, attracts insects and the whole furnishes both drink and food for certain birds and mammals. Hither came Oropéndolas, Tovi Paroquets, Woodpeckers,

[1] *Virola panamensis.* [2] *Didymopanax morototoni.*

and an occasional Hummingbird. The former stand at the side of the cup and help themselves over its edge, but the Woodpeckers drill a hole near the top of the calyx and get their meal, as it were, on the side. Paroquets stand on the rim of the petals and Hummers hover above them as they dip within.

One evening while we were at the supper-table, from which we can plainly see the balsa as well as be seen from it, a Capucin Monkey, as though drinking our health, took a blossom in both hands and held it to his lips. It seemed wholly natural to raise my glass in response. After nightfall I sometimes see small animals, probably Opossums, running out on the bare limbs toward the blossoms and quickly returning, possibly after a hurried drink. The tree blooms through the dry season and is therefore a constant source of attraction both to me and its numerous native patrons.

Second in my list of feeding-stations is a tree about 120 feet in height, with rather slender, grooved, and twisted trunk and an open crown of small, acacia-like leaves. I have never secured its blossom and do not know its name. But of more importance to me than its identity is the fondness Howling Monkeys display for its buds and fresh leaves. From the time the buds begin to swell until the leaves are fully grown the laboratory clan of Howlers make

their headquarters in this vicinity and visit the tree usually twice daily. They are honored guests and they comport themselves with dignity. Occasionally, after feeding, one remains to curl up in a ball at the top of the tree and doze in the sun.

Through my interest in the Monkeys I have noted much variation in the dates when this tree acquires its leaves. In 1927 Monkeys were first seen eating its buds on February 15; in 1928, on January 31; on the following December 20, when I arrived, the leaves seemed fully grown and the Monkeys were reaping the last of their harvest.

The nutmeg is a stately tree with a trunk as straight as that of a pine. About eighteen inches in diameter at the base, it decreases but little in size until, a hundred feet above the ground, it divides into many limbs that support a rather compact head of finely cut, light green leaves. The yellow fruit ripens in the latter part of February. About the size of a plum, it is too large for the smaller birds, but with Motmots, Toucans and Trogons it finds great favor. Hither come many Rufous Motmots in the gray of the dawn to feed as well as hoot. They pick the fruit while on the wing, not with the dash and directness of Trogons, but while fluttering before it. There is apparently nothing in their structure that compels this habit. They are not

unduly heavy, they have fairly strong feet in proportion to their weight, their bill is serviceable, and there seems to be no reason why they should not pluck the fruit while perching near it.

Between fluttering sallies, and probably while waiting for one nutmeg to make way for another, the Motmots sit and wag their tails in jerky twitches from side to side and add a few hoots to the hooting chorus which at this hour is the dominant bird-note.

Before the Motmots retire to the forest and silent meditation they are joined by the large Massena Trogon. The smaller, yellow-bellied Trogons evidently cannot encompass the nutmegs. Shortly after sunrise both species of the large *Ramphastos* Toucans follow. They file into the tree one after the other, and when a dozen have arrived, and a few Motmots and a Trogon or two still remain, the nutmeg presents an animated picture of tropical bird-life.

One morning two Swainson's Toucans flew from the mangabé to the nutmeg. One alighted at the end of a thickly-leaved limb; the other on the same limb but nearer its junction with the trunk. Here it was fully exposed and in bright sunlight. A few minutes later Number 1 hopped up to Number 2. He had a ripe nutmeg in the tip of his bill, but it was evidently not grasped firmly enough to enable him to swallow it by throwing his head back, his bill up. He tried,

therefore, to improve his hold by pushing the nutmeg against the limb on which he was perching but on the second attempt it fell, leaving a piece in the tip of his bill. In no way disconcerted, he (I now assumed that the bird was a male) hopped nearer to Number 2 (who I now assumed was a female) and offered her the bit of fruit remaining, which she promptly and skilfully took and swallowed. Supposing that this was all he had to offer I rated his generosity accordingly. But, behold! the fragment of nutmeg was suddenly replaced by a small berry, apparently from the mangabé tree. This the female also deftly accepted. But where did it come from? By what sleight of bill did the male produce a berry where none had been before? He now jumped gallantly to the other side of the female and offered her a second berry. Through my 24-power binoculars, which made the birds seem not more than ten feet away, I clearly saw this berry come up his bill as though impelled from his throat, for he apparently did not drop his bill below the horizontal. This the female lost, but a third and fourth berry were taken. Then both flew off together.

It is always pleasing to observe these exchanges of courtesies between birds, but between Toucans they were emphasized by the bird's size, its pronounced personality and caricature of a bill.

The following week I made an observation that cast strong doubt on my assumption that the generous Toucan was a male. There was an unusually large gathering of both Swainson's and the Short-keeled Toucans in the nutmeg and adjoining trees. If they came to feed they remained to sing. The air resounded with croaks and yelps. With a characteristic upward jerk of the bill, a Swainson's Toucan was enthusiastically contributing his "*Dios te de*" to the chorus when another bird of his species hopped up to him and at the tip of her (?) bill presented him with a piece of nutmeg. He stopped his song to accept it and as a further reward three more pieces followed. On this occasion, at least, the bill of the donor was slightly lowered as the bits of fruit went from throat to bill-tip.

The Motmots were never, and the Toucans infrequently, seen in the nutmeg tree after their morning meal, but the mangabé was patronized throughout the greater part of the day. It is a slender, gray-barked, open-limbed, dome-topped tree about 100 feet high, and stands just behind the nutmeg. The leaves are large, elliptical, dull green above and brown below. They grow on long stems and eight or nine radiate from a common center, making a perfect wheel-rosette about two feet in diameter. At the base of the long stems bearing these rosettes are

great clusters containing hundreds, and even thousands of small, flattened, hard gray berries or thinly covered seeds; at a distance they suggest bayberries. Like chick-feed, which is eaten by every fowl in the

Aracari Toucans in the Mangabé Tree

poultry-yard regardless of size or age, these berries are eaten by Guans as large as a hen turkey, by Manakins the size of one's thumb, by Toucans with bills nearly as large as their bodies, and by Honey-

creepers with bills like needles. But without regard to size of bird or bill the rule is one berry at a time. For this reason the tree's supply of berries lasts two months or more and during this period it is the common meeting-ground for birds of many species and of diverse form and habit.

There are few minutes from dawn to dusk when some birds are not in its branches. Nevertheless, in spite of its comparative openness, it is very difficult to see them, and, as a rule, only movement reveals their presence. Even the large Crested Guans, or Pavos, are not readily detected when they are in the denser foliage, but often they perch amid the topmost clusters of fruit and are then sharply silhouetted against the sky, a position which suggests that they fear no attack from above. Here, from the surrounding abundance, they help themselves freely, picking here and there until their hunger seems satisfied. How many berries they eat at a sitting I do not know, but a Honeycreeper seems content with three or four. He takes them slowly, with long enough pauses between to dispose of one before it is followed by another.

Toucans are among the most regular patrons of the tree. In addition to the Short-keeled and Swainson's there is also the smaller, Aracari Toucan. Whatever be the purposes for which the Toucan's bill was

Swainson's Toucans and Crested Guan
(*From a drawing by F. L. Jaques, courtesy The World's Work*)

"Poor-me-One"

A slightly wing-tipped bird photographed in Trinidad, March, 1893. When perching, the bird assumes an upright, protective pose. (*See page 262.*)

designed, there can be no doubt that it greatly increases the radius of his reach. Without changing his perch he pecks berries above and below, before and behind him, and at surprising distances. For a time he sits motionless or very slowly turns his head from side to side. Then, with unexpected quickness, the bill is thrust out and the berry deftly taken with the sharply hooked tip. The head is then tossed back, the bill upward, and the berry is swallowed.

All the island Trogons find these berries suited not only to their tastes but to their feeding-habits. They should be known as fruit-catchers among birds. Just as a Flycatcher, darting from his perch, takes his prey on the wing, so do Trogons dart at their food, grasp it with their strong, serrate bills, and by the impetus of their flight pull it off in passing. Or they may flutter a moment before it and, having secured hold, throw themselves with spread wings and tail backward, detaching it chiefly by the weight of their bodies. The fruit plucked, they may continue their flight to a new perch or return to the old one. Of necessity the fruit must not be larger than a mouthful, and for this reason their fare is chiefly restricted to berries of various kinds. Sometimes I see the smaller, yellow-bellied Trogons fluttering before wasps' nests attached to vertical limbs picking something from them, possibly larvæ. Primarily,

however, Trogons are fruit-eaters, and they possibly employ the methods of Flycatchers because their food, while stationary, is often beyond their reach as perchers. Trogons are weak-footed, comparatively

A Graceful Trogon "Catching" Fruit

heavy-bodied birds; the berries on which they feed grow at the ends of branches too small to offer them a footing so they approach them from the air. In the mangabé tree it would be possible for them to sit at table, as it were, but force of habit probably impels them to feed in their characteristic manner.

It seems obvious that the well-developed serrations on the edge of both mandibles in the Massena Trogon greatly increase their grasping power, but it is difficult to explain the serrations on a Toucan's bill which point toward the end of the bill and consequently in the same direction as the pull.

The remaining visitors to the mangabé tree vary more in form than they do in feeding-habit. The additions include Pigeons, Woodpeckers, Flycatchers, Manakins, Cotingas, a Grosbeak (*Pitylus*), Honeycreepers, Tanagers, and Orioles. The mangabé, therefore, perhaps more than any other tree in the forest, may claim to produce a universal food for fruit-eating birds. But, strangely enough, I have never seen Parrots in it.

On the westerly side of the clearing the ground descends abruptly to a brook which runs throughout the year. The slope is planted with bananas and the winding pathway to the water is arched by their broad leaves. Just within the border of the forest, where the stream has been widened, there is a little pool where Donato and Enemicia come to bathe. Distant not more than a minute's walk from the laboratory, the place is so hidden by vegetation that one seems to have reached some remote part of the island, if not, indeed, of the world. I often go there to enjoy its beauty and the sense of added isolation.

In January and February, 1928, the ground here was strewn with the partly-eaten nuts of an almendro,[1] or so-called wild almond, growing from the brookside. This is a favorite food of the Coati, and for two months the tree was a focal point in local Coati life. A mature almendro reaches a height of not less than 150 feet; the one at the brookside is not more than half-grown, but in 1928 it was laden with fruit attached to the extremity of the branches. Not one, however, seemed to grow beyond the reach of the Coatis. It was unusual not to see from one to six of these animals in the tree, but rarely, if ever, were two observed on the same limb. They galloped up the main limbs but in descending often set their legs and slid down like a mule on a steep trail. Their tail is not prehensile and serves merely as a balancing-rod, or when laid over a limb it may assist them as a prop. It was astonishing to see how readily these heavy-bodied animals maintained their position on limbs which seemed too small to support them. No part of the tree was beyond their reach, and when the fruit could not be plucked direct, the limb on which it was growing was dextrously drawn inward. Many terminal limbs were thus broken and as the season advanced bunches of dead leaves were seen all over the outer parts of the tree.

[1] *Coumarouna panamensis.*

The fruit of the almendro is flattened, elliptical, about two and a half inches long and half as wide. The Coatis, holding it in their forepaws, gnaw off with their molars the thin layer of rather sweetish flesh, brown without, green within. Much, however, adheres to the large, hard seed, and these green-coated nuts, plainly bearing the fresh marks of teeth, were a puzzle to me when I found them in abundance beneath forest trees. Approach as cautiously as I could, I never found an animal eating them. Finally, one was dropped on me and I saw a Coati at work overhead. On the ground they are further eaten by Agoutis who also get a part of the nut's kernel. Pugnacious as the Coatis are on the ground, I never saw them dispute each other's right of way in the almendro. Footing and food seemed then to occupy all their attention. Toward the end of February the only nuts left in the tree were at the tips of the smaller branches, where they were beyond the reach of the larger Coatis. Then the smaller animals had their innings, and for nearly two weeks only young Coatis were seen in the almendro.

I rarely see birds bathing or drinking at the brook but there are often many feeding in the trees above it. Their period of greatest abundance is determined by the flowering of the madroño[1] and ripening of a red

[1] *Macronemum glabrescens.*

berry that grows on a vine a few yards below the almendro. The trees are not high and by ascending the bank toward the laboratory one can be on a level with their upper, or flower- and berry-bearing, half. At this distance no glasses are needed to obtain a satisfactory view of the birds that come to feed. From my journal of February 12 I quote part of a record of a morning's observations here: "The setting, pictorially, was perfect. The brilliant red berries and polished green leaves shone in full sunlight and the even more brilliant green and red of the Massena Trogons were emphasized by the birds' movements as they swung from one side of the tree to the other and took a berry at each passing. About ten berries satisfied them and they were followed by a Swainson's Toucan, while four Marmosets, climbing a tree, passed directly back of an opening in the berry tree. It formed a picture of tropical life even more alluring than the drawing on the cover of an ancient geography. Meanwhile the pink blossoms of the madroño were not without their visitors. Hummingbirds of several species balanced on blurred wings before them, and one of emerald-green with a gold-bronze tail (*Amazilia tzacatl*) explored the midrib of the banana leaf over my head in search of insects.

"There were intensely blue Honeycreepers whose

colors looked dark and dingy when a brilliant Morpho butterfly, glittering in the sunlight, pursued his erratic course down the stream beneath them. A pair of exquisite Blue Ground Doves passed to and fro, sometimes the male, at others the female, leading, and overhead the Oropéndolas, calling, working at their nests, or coming and going furnished a background of communal activity."

In December, 1925, when first I came to Barro Colorado, there were three dead trees standing on the brookside slope. The cavities in the limbs of one of them offered nesting-sites to several birds so unlike in structure and habits that we should not expect to find them associated while nesting. A pair of Pucheran's and another of Malherbe's Woodpeckers occupied holes which they had doubtless made for themselves. Two noisy Noble Flycatchers had appropriated an abandoned Woodpecker excavation, and a pair of Black-winged Palm Tanagers were living at the end of a limb in a cavity caused by decay. The Malherbe's Woodpeckers launched their family about February 20. The remaining species were still occupied with family cares when, at that time, I left the island. In addition to the species named, the Aracari Toucan, Blue-headed Parrot, Tovi Paroquet, Costa Rican Tityra, and Fraser's Erator all made frequent visits of inspection to this apartment tree,

and possibly one or more of these species may have found a site to its liking.

To commit a so-called hibernicism, dead trees are short-lived in the tropics. Attacked by termites, they usually soon succumb. The apartment tree fell the following summer, a second the next winter, but the third still stands, though it has lost most of its limbs. It is evidently of exceptionally hard wood, and for that reason has resisted birds as well as insects. A pair of Pucheran's Woodpeckers, after prolonged, persistent effort, have chiseled a home in it, but the much larger Panama Pileated and Malherbe's Ivory-bill long ago abandoned their attempts to penetrate its trunk.

This tree is a favorite perch of Ghiesbrecht's Hawk. Here, and also at the entrance to the forest across the clearing, it sits literally by the hour. A pair of these beautiful birds usually live near the laboratory, and at the sound of their long-drawn, thin, piercing cry one always looks until he finds them just for the pleasure of seeing their snowy white bodies circling against the sky. No color could make them more conspicuous. Even in the gloom of their forest haunts they can be readily seen. It is difficult, therefore, to imagine what part their color plays in protecting them from possible enemies or in enabling them to approach their prey. This consists largely of

An Avian Apartment

On February 20, 1926, four species of birds were nesting in this tree and five others were looking for sites. At the left is an Aracari Toucan, opposite Malherbe's Woodpeckers and their nest-hole; above, in the crotch, is Fraser's Erator, up the left limb is a Noble Flycatcher, up the right, two Pucheran's Woodpeckers, and at the right two Blue-headed Parrots.

The tree was photographed; the figures of the birds were drawn by F. L. Jaques.

The Hummer's Nest of 1926

The bird may be seen on the nest near the end of the long, slender, nearly limbless branch

The Hummer's Nest of 1927

The limb occupied the preceding year having fallen, the nearest limb was chosen for a site. The nest is near the bottom of the picture.

(*See page 133.*)

tree-snakes, and most of the snakes I have seen on Barro Colorado have been dangling from the claws of passing Ghiesbrecht's Hawks. Evidently they also feed on the ground and doubtless on frogs and lizards, as well as on snakes. I captured the image of one with a camera-trap set in the bed of a brook and baited with a fish-head.

On March 9, 1929, I found a nest of this species placed near the top of a tall tree on the Lutz Trail. One of the Hawks sat beside it with a small, green-leaved twig in his bill, looking like a caricature of the Dove of Peace.

THE SANDBOX TREE

The sandbox tree, in which the Oropéndolas nest, is the center of avian population in the clearing as well as the airport for many feathered aviators on journeys which may lead across the clearing or to the United States.

Guans sail quietly into it and as quietly depart. For large and, at times, painfully noisy birds, they can, at will, be surprisingly inconspicuous. Parrots, whose cries drown all other sounds, arrive and at that moment become invisible as their green plumage merges with the color of the leaves. However vocal they may be when in the air, they become silent and motionless on alighting. Usually their stay is short

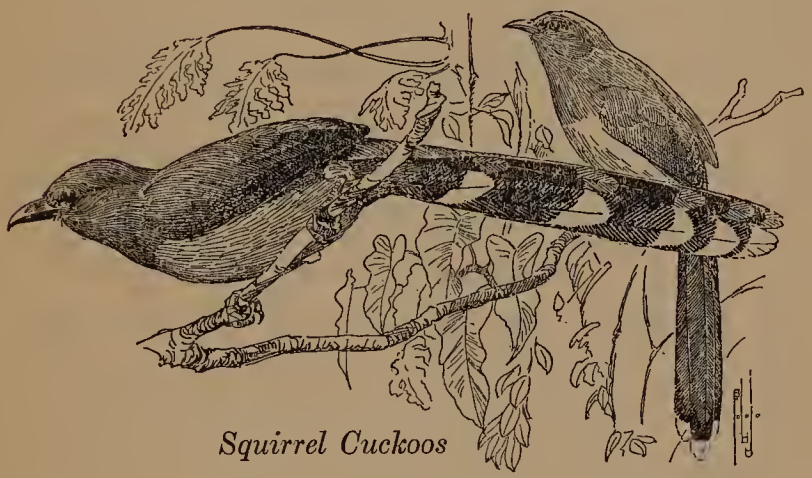
and they take wing from the perch on which they alighted. Paroquets, on the other hand, are twittering about the tree most of the day.

Trogons, both the large, red-bellied Massena Trogon and the smaller yellow-bellied species, often use the sandbox as a singing station, and the latter feed from the wasps' nests on its upper limbs, as I have already said. Toucans come to sing or rest, usually seeking the more densely foliaged parts of the tree. Although often associated in small companies, they seem to lack the group-impulse that prompts most social birds to fly in close flocks, turn, wheel, alight, and take wing as though they possessed a mind in common. Toucans, on the contrary, fly singly, one after the other, and about a second apart. This is particularly true of the small Aracari Toucan for the appearance of one is a sure indication that another will follow, until, at times, a dozen or more have passed.

The large, long-tailed Squirrel Cuckoo is one of the few birds that comes to the sandbox for food. In the course of his rounds he explores the lower branches for insects and probably small lizards, calling occasionally his sharp *peek*, dry *piscátaqua*, *piscátaqua* or little staccato crow, *chick-kaw*, one of the most characteristic of tropical bird-notes.

On one occasion, while I had a Pied Puff-bird under

observation through my glasses, he cocked an eye upward, then quickly swung under the limb on which he was perched, in some way still retaining his hold. At this moment a Turkey Buzzard sailed low over the tree and no sooner had he passed than the Puff-bird resumed his normal, upright position; a rather clever maneuver for a bird invariably classed as



Squirrel Cuckoos

"stupid." I often see two of these birds in the tree and have looked vainly for their nest in a termite or deserted wasp-nest.

At 9.20 on the morning of March 22, 1927, thirty Kingbirds (*Tyrannus tyrannus*) suddenly entered the tree. I did not see whence they came but within a minute twenty-one of them flew southwest. The remaining nine swung out after insects for about five minutes—a bite snatched *en route*—and then followed those that had gone before. Although

bound north, the direction of their flight indicated that they were following the trend of the land rather than an airline toward their destination. However, they were not due in the latitude of New York until the last of April and could afford to take the safer route. They carried no mail-sacks and still brought a message to every bird-lover who met them on their arrival.

This is the only migrant I have seen in the sandbox tree, but another bird that brings with it thoughts of home is the Panama Robin. It is not common on Barro Colorado, but on some memorable evenings it has sung its vesper song from the topmost branches of the sandbox in a voice so like that of our American Robin that I was mentally transported to another land. It is the only bird-song on Barro Colorado that makes one wish to be elsewhere, though sometimes, I confess, I wish that the Parrots were elsewhere!

Honeycreepers and small Tanagers of the genus *Tangara* are more often seen in the sandbox than in their forest haunts, and here, too, is one of the few places in which I get a glimpse of the Slate-colored Grosbeak, one of the most notable song-birds heard about the clearing.

Of these transient visitors to the sandbox I have a list of just over fifty species, but the tree's true in-

habitants are the birds that make their nests in its branches. First among these, of course, are the Oropéndolas. It is, indeed, their tree, and a study of their life in it occupied the greater part of my first three seasons on Barro Colorado, with results related elsewhere.

The Cotinga, whose only known nesting-site is in the sandbox, and the Black-throated Hummingbird who reared her young there, also have a chapter of their own.

The Flycatcher, *Legatus*, and the Cowbird, or Rice Grackle, *Cassidix*, are so intimately associated with the Oropéndolas that their history belongs with the story of that species. But there are still to be mentioned the Colombian Flycatcher and Blue Tanager. Both are among the commonest of tropical birds, characteristic of open rather than forested regions, and the clearing accounts for their presence near the laboratory.

The Flycatcher built its bulky nest of grasses in the upper branches of the tree, but the Tanagers chose for their nest-site a bunch of parasites about thirty feet above the Hummingbird's nest. The lower part of this vegetation was the home of a large colony of stingless bees (*Trigona*) which in a dense swarm were frequently seen almost enveloping the parasites. Through these buzzing but harmless neigh-

bors the Tanagers flew when going to and from their nest. What a din in which to rear a family!

SOME RECENT ARRIVALS

In addition to the forest birds which the clearing has revealed, there are the birds which have come since the trees disappeared. Some have succeeded and are increasing, others have not established themselves and have disappeared. Probably one of the first settlers in the clearing was the Panama House Wren. In looks, habits, and voice this bird so closely resembles our North American species that any person familiar with one would immediately recognize the other. Indeed, I have been asked if the Wren seen in Panama is not the North American bird in winter quarters!

Progressive and adaptable, animated by the spirit of the pioneer, the House Wren has a wider range than any other land-bird of the Western Hemisphere. From Cape Horn to Canada, from the base to the summit of the Andes, in the dense forests of Chile, the arid deserts of the Pacific, or the humid valley of the Amazon it seems equally at home. As far north as Mexico it is represented by resident, intergrading races. Then occurs a slight break in our records, some day to be filled, and beyond this lies the country of our North American *Troglodytes aëdon*.

A box with a hole in it attracts the Panama race just as it does the North American bird; but, as in many other species, the more southern form lays only half as many eggs as its northern cousin, four instead of eight eggs constituting a set. The smaller clutches of eggs of tropical birds are commonly attributed to their presumed lower vitality and consequent diminished reproductive powers as compared with those of Temperate Zone species. But the Panama House Wren seems fully as active and irrepressible as its northern relative. From the time of my arrival on Barro Colorado (about December 20) until my departure (April 1) it is always in song. Moreover, the song is louder, more musical, more varied, and longer than that of the northern bird. Sometimes I hear in it a suggestion of a Song Sparrow's song; at others it has a trace of the lyrical quality of the lay of the Vesper Sparrow.

The call-notes differ greatly from those of our House Wren. I write them as a grating *cloudy-ditch, cloudy-ditch,* quite unlike, therefore, the northern bird's more simple *cacking.* Vocally, however, Panama birds, or perhaps I should say the Wrens at the laboratory, are distinguished by the song of the female. She is not a soloist and, as a rule, gives voice only when she hears the song of her mate. He may be with her or a hundred feet or more away. When

he sings she sits with fluttering wings uttering a *twit-twit-twit-twit-tee-tee-tee* with enough musical quality and volume to deserve the name of song. Generally she keeps time with her mate, sometimes she is a little ahead, reacting perhaps to his opening notes that I may not have heard; sometimes she is a little behind him.

In 1928 there was but one pair of House Wrens in the immediate vicinity of the laboratory. It was, therefore, presumably this pair that made a nest under the northeast peak of the laboratory eaves which early in January contained four eggs. The site was not readily accessible, and when the nest was examined ten days later the eggs had disappeared.

On December 26 I had placed a nesting-box in the shadow of the overhanging roof at the east end of the guest-house, but it was not until January 19 that two birds were seen inspecting it. Evidently they at once approved of this new type of nest-site and on January 21 they took possession and began to carry in twigs and grasses. Both sexes worked and on February 2 the box was partly filled with material and a nest occupied one corner of it. The nest was not examined again until February 7, when it contained three eggs. A fourth egg was laid on the 8th. On the 9th a lining of feathers was added to the nest but incubation, apparently, did not begin until the

11th, when for the first time I found a Wren in the box at nightfall. The eggs hatched on the 22d. On the 23d the female brooded while the male sang, but I saw no feeding until the 24th. Then, at 9 o'clock in the morning, he came out of the box; she followed, and they sat for a moment at the doorway while he sang. He then left while she waited expectantly. In a moment he returned with what looked like a small green worm which he presented to her. She entered the house with it; he sang and left. Again she waited in the doorway, looking eagerly this way and that; again he came back with food and on this occasion he entered the box with her. After five or six seconds he left while she remained watching for him from just within the doorway. This time he returned with a beetle, sang from the top of the box, then hopped down and delivered the food.

This was the usual method of procedure in this well-ordered household. He was the provider; she was the nurse. If, however, she was not waiting for him on his return with food he entered the nest and evidently gave it to the young himself, and the one who fed the young was the one who cleaned house. Usually he sang after delivering the food and when not too occupied she sometimes sang with him. Their actions all seemed most reasonable and based on complete mutual understanding.

On March 9 when I examined the nest one young bird flew; at 7 o'clock on the following morning the remaining three had followed, and the parents were apparently feeding them in the undergrowth. Two weeks later the male was still singing fully and freely and at times the female joined him. Here my observations for the season ended.

A second Wren-house, placed December 26 on another building thirty feet or more from Number 1, was not occupied, and on February 18 it was moved to the Shannon House, near the water. There were two pairs of House Wrens in this vicinity; whether both occupied the box or not I am unable to say, for other matters claimed my time. However, when leaving the island at the end of March, I discovered that the box held two nests each containing eggs. Here possibly was a lost opportunity to study unusual domestic relations. But Barro Colorado offers so many opportunities that one must reconcile himself to the loss of most of them if he would concentrate on one. The House Wren's history on the island is, however, of exceptional interest and presents a well-defined problem which promises results not alone in bird-biography but in determining the factors that limit the number of individuals of a species within a circumscribed area.

It is about the Shannon House and among the

bananas on the adjoining slopes across the brook that most of the recent additions to our avifauna may be found. Where grass grows beneath the bananas and papayas, the little Seed-eaters, so small that they cling to a single grass stalk or, trogon-like, hover before its seeds, are common. These diminutive Finches are notable neither for their colors nor voice, and their chief interest on Barro Colorado is their discovery of new but narrow feeding-grounds as soon as food is ready for them.

Here also, at times, may be seen three beautiful Tanagers whose prevailing colors are respectively blue, black and red, and black and yellow. All are about the size of our Scarlet Tanager but none can rival him in color. He is, indeed, one of the most striking members of a family containing about 350 species, most of which are brilliantly plumaged.

Colombian and Cayenne Flycatchers with rich yellow breasts perch on the banana leaves, whistling softly, and where the second-growth has escaped the machete, barred Antbirds sound their dry, wooden rolls. Anis, locally known as "Vaqueros" and "Garrapateros," or Cowboys and Tickcatchers, because of their habit of associating with cattle which they relieve of ticks, hunt actively through the grass for insects. A strange bird, this, of pronounced character, notable for its primitive marital customs.

They live in bands of from three or four to a dozen, and build but one nest in which as many as two dozen, bluish, chalk-covered eggs may be deposited. The duties of incubation and the care of the young are shared, a form of coöperation which is evidently successful, for Anis are among the most common and widely distributed of American tropical birds. Their early arrival in our clearing is an indication of their enterprise and evidence of an overflow population seeking new ground. They are neither pleasant to look at nor to listen to. Their plumage usually seems worn and shabby, their voice is whiny and disagreeable, but an intensive study of their singular nest-life should yield as yet unknown facts regarding communal nesting habits among birds. Only three or four of these birds have yet arrived and a record of their attempts at colonization should be kept.

Anis

Far more welcome, from a music-lover's point of view, are several Wrens of the genus *Thryophilus*

which came in the early days of the clearing, but, to my great regret, the rapid growth of the vegetation along the forest borders is evidently not to their liking. Far from increasing, they are disappearing. I miss their loud, ringing, cheerful notes.

It is not charm of voice that wins a welcome for the Turkey Buzzards, nor do we require their professional services. It is for the sheer joy of watching their flight that we value them. When the trade winds supply them with an unfailing source of power, they make, in truth, perfect pictures of repose in motion. There is not the slightest visible evidence of expenditure of energy. The bird seems as air-borne as a bit of thistle-down, and yet it is completely master of its movements. It swings up the narrow passages between our promontory slopes and the walls of the forest, makes a "hairpin" turn and sails back again; now it is above us, now below, no maneuver seems too difficult, and only a tilt, this way or that, of the ever-spread wings is required for its performance, and so accustomed have we become to airplanes that the amazing thing about these surprisingly perfect evolutions is their noiselessness!

To the Buzzards our clearing is simply new hunting-ground. They are not confined to a certain type of habitat but roam wherever food may be found over forest or plain or shoreline, in town or country.

But to the Anis, Seed-eaters, Antbirds and other new additions to our fauna, the clearing is a true home and their presence in it marks them as successful mainland species. They represent the surplus life which, after an environment is filled, must find new territory or perish.

Among mammals, Coatis have derived the greatest benefit from our clearing. Here temperament has played a part. To the Coati we are not a source of danger but of food. It is an amusing, but aggravating sight to see one climb nimbly up a papaya trunk, perhaps fifteen feet in height, cut the melon-like fruit from its stem, and, as it falls, jump after it to give chase as it rolls down the hill. We have therefore been obliged to encase a few feet of the trunks of fruit-bearing papayas in tin to protect them from these omnivorous animals.

It is more amusing and, to us, in no way aggravating to watch a Coati try to gain access to an evaporated milk can from which the contents have been removed through a nail-hole. It must be confessed that he shows surprising persistence and dexterity of manipulation and abandons the attempt only when he is convinced that the task is impossible.

Collared Peccaries have so willingly exchanged a fare of forest products for our cassava and yams that we no longer attempt to raise these vegetables.

Peccaries are also attracted by the fresh growth of grass and sprouts that appear in the clearing. At times a band of these animals will feed for six or seven consecutive days at the border of forest and clearing.

The depredations of these two animals illustrate the difficulties encountered by the pioneer who hews his home out of the wilderness and in the attempt to raise food-plants must combat the native fauna.

Even more disastrous, because more numerous and less easily controlled, are noxious, indigenous insects. One winter we attempted to grow tomatoes on Barro Colorado. Soil and climatic conditions were favorable but from root to fruit the plants were attacked by so great a variety of foes that only those placed in boxes and given constant attention bore tomatoes; excellent ones, they were.

THE END OF THE DAY

Tropical midday is a period of rest for bird and beast, and man does well to follow an example that is based on sound principles. Even the Oropéndolas are silent, and the soothing sound of the trade wind in the forest creates a prevailing sense of repose and peace. The evening comes gently. From the lower growth, whence he rarely ventures, a Blue Grosbeak sings his naïve little melody, Doves coo, the female

Oropéndolas return to work, the males to woo, and their plague, the Flycatcher (*Legatus*) resumes his wearisome *pee-ee; tiddle-dee-dee.* Buzzards, undiscouraged by their apparently fruitless search, continue their aërial scouting over the clearing. The fruit trees again become focal points of interest and activity, but are never as popular in the afternoon as they are after a night's fasting. The House Wren, after what one might well believe was an enforced rest, sings again with renewed energy. Other birds repeat more briefly their morning songs, but with the Toucans and smaller Motmot the sunset hour is a favorite singing time. *Dios te de* calls as fervently as though he were giving thanks for all the birds of the island, the Short-keeled Toucans join in a frog-like chorus and the Broad-billed Motmot croaks dismally.

Lawrence's Woodcreeper

The average time of sunset from January 1 to

April 1 is 6.25; the extremes, 6.11 and 6.30; but with us, on the northeastern slope of the island, the sun disappears some minutes earlier. To the Antbirds on the forest floor dusk must come still sooner, and from their somber haunts they sing their evening songs while the clearing is still golden. As the shadows creep over us, the light seems to go more rapidly. Wild Pigeons of several species fly eastward at a great height and at a speed that rivals the airplanes. The female Oropéndolas, after quietly making their toilets for the night, one by one enter their nests, and the males take reluctant flight to their lonely roost in the forest. Woodcreepers whistle loudly and the Chestnut-headed Tinamou flutes his solemn vesper. A Bat Falcon on rapidly beating, keen, curved wings, hurries through the dusk. Out in the lake the canal buoys, under the influence of decreased light, suddenly shine white and red, and the Parauque, equally sensitive to growing darkness, calls *hip-hip; hip-hip; hip-hip-hooray.*

CHAPTER IV

THE OROPÉNDOLAS OF LABORATORY HILL

THERE is a yellow and black bird in Europe which builds a somewhat pensile nest. In England it is called Oriole; in Spain, Oropéndola. The English name was given to an orange and black bird of eastern North America, further distinguished because it wears the colors of Lord Baltimore, as Baltimore Oriole. The Spanish name was applied to various black and yellow birds of tropical America. To say that neither of the American birds is an Oriole, any more than our Robin is a Robin, is to protest futilely against the force of custom. To add that the so-called Oropéndola of Barro Colorado should be known as *Zarhynchus wagleri* is an idle exhibition of pedanticism. Oropéndola it is and Oropéndola it will remain. But, to distinguish the particular species with which we are here concerned, possibly we may compromise on the book-name of Wagler's Oropéndola. After all, this is merely a name, and to give it a meaning we must add that the male Oropéndola, that is, Wagler's Oropéndola, is a large,

black bird which, seen at close range, has the head, neck, throat, and breast seal-brown, the rump chestnut, and all but the central pair of tail-feathers and outer margins of the outer pair, yellow. The peculiar shape of his bill, with its greatly swollen base, and his habit of parting his scanty crest in the middle and brushing it both ways are shown in Mr. Jaques' plate. The male is about fifteen inches long; the female about four inches shorter and with a shorter crest, somewhat duller plumage, and a much smaller bill.

Doubtless long before Barro Colorado became an island Oropéndolas nested on Laboratory Hill. At any rate they were there when the site was selected and, on March 29, 1924, the day the laboratory building was dedicated, the Oropéndolas from their nests in the branches overhead must have witnessed the exercises. Their continued occupation of the site seemed to place the stamp of approval on our selection; and, as proof that they did not object to our presence, they returned to their nest-tree the following year.

The season brought sad evidence that primeval conditions cannot long continue after the advent of man. With the best of intentions he is bound to become a disturbing element. When the forest was felled, the Oropéndola nest-tree was deprived of the

protection from the wind it had always received. In its sheltered youth it had developed no power—in other words, no system of rootage—which would enable it to resist the forces it was now obliged to combat and, on June 26, 1925, it was blown to the ground. At that time it contained fifty-seven Oropéndola nests. In one there were two nearly grown young birds; the remainder were empty.

The following season, prompted by the homing impulse that year after year induces a bird to nest in the same place, the Oropéndolas, who live in the vicinity the year around, returned from their local wanderings to Laboratory Hill and, finding that their family tree had fallen, they settled in the nearest available site. This was a superb sandbox tree over 130 feet in height, with wide-spreading limbs almost overhanging the laboratory. Soon their long, pendent nests were swaying from its branches. This was my first season on Barro Colorado but it was by no means my first meeting with nesting Oropéndolas. I had seen them in Mexico, Colombia, and Trinidad; but it was the first time I had lived with them. It was both cheerful and reassuring to have them, undisturbed, proceed with their affairs above while we attended to ours below. Their presence added an air of animation to the life of the laboratory. We were awakened by the call to work of the males in

the morning; we watched them retire in the evening. Throughout the day we heard their notes and saw them come and go. We applauded the males' ardent courtship and marvelled at the females' skilful needlework. A single bird's nest, with the domestic life that centers about it, claims and holds our interest from the time its foundation is laid until the miracle is completed and the young take wing. But here were forty or more birds' nests. Was it a chance gathering of birds attracted to one tree by force of habit or because its location and branches offered them suitable nesting-sites? Or was this an organized community, a little bird-village whose citizens found it mutually beneficial to associate when nesting? There was nothing in my own experience to answer these questions. Hitherto, when meeting Oropéndolas, I had been content to collect specimens of the birds and, in places, their nests, but of their lives I had learned only what one may see in passing.

The records of other naturalists were as unsatisfactory as my own. It was impossible, however, for me to associate day after day with these birds without developing a keen interest in their ways, the significance of their calls, and their family relations. Did they come each year at the same time? Did they come alone, in pairs, or in groups? If they were not

mated when they arrived, what were their courtship customs? Who selected the nest-site, gathered the material, and built the nest? How was this long, firmly woven bag constructed and how many days were required to complete it? Was it used again? How many eggs were laid, and who incubated them? What was the incubation period? Who cared for the young? At what age did they take wing? What were the relationships of the individual bird to others of its own species? Had it any association with other species? If they had any enemies, who were they? How did they avoid them? Why did they nest in colonies?

As a contribution to bird-biography and to a better understanding of the relation of a species to its habitat, these questions seemed well worth answering. If replies to them could not be found in books it remained only to go to the birds. Certainly I should never have a better opportunity to study them. In a sense I was almost a member of their colony; at least we both belonged to the same community and for months lived in close and constant association. I appointed myself, therefore, official historian to the Oropéndolas of Laboratory Hill. The story of their lives was not to be written in one nesting season or in two. Three years at least would be required to determine whether an observed act was an incident, a

An Oropéndola Wooing

The male (above) passionately addresses the female, who, ignoring him, continues weaving her nest. She has completed the loop which, subsequently, becomes the entrance to her dwelling.

(Reproduced from a drawing by F. L. Jaques, by courtesy of The American Museum of Natural History)

The Oropéndola Colony

Photographed with a 14-inch lens from the standpoint whence the birds were studied. The ridge of the laboratory roof appears in the lower right-hand corner.

A Student of Oropéndolas

The 24-power binocular and desk-chair in action
(*Photographed by F. E. Lutz*)

coincident, or a habit. Even then I should have recorded the habits of only a colony as a contribution to a work on the customs of the species; but it would be a beginning.

The chief object of my first visit to Barro Colorado was to make field-studies and help my colleagues, Jaques and Potter, gather material for a Habitat Group of the bird-life of a tropical forest. This is now on exhibition in the American Museum. Time, not claimed by this occupation and Barro Colorado itself, was devoted to the Oropéndolas. I was armed, however, with only an 8-power glass, which, I later discovered, did not tell half the story.

During the two succeeding seasons, watching the Oropéndolas was my principal occupation, and the conditions under which they were studied were far more satisfactory. My observation-post was the open space beneath my house, situated about 100 yards from the Oropéndolas' tree and fifty feet below the average nest-level. Seated in a camp-chair with a desk-board across its arms, and using a 24-power binocular mounted on a tripod, the birds, wholly unaware of my presence, seemed to be within reach of my hand. Every detail of their movements, even to the vibration of the tongue when calling, could be clearly seen and with such ease that I could observe and record their actions for hours at a sitting

without fatigue, and hence without loss of interest. Diagrams were made showing the relative positions of the nests. Each nest was numbered and, as far as possible, its history recorded.

The principal results of this vigil have been published at length in the "Bulletin"[1] of the American Museum. I will summarize them here.

THE COMING OF THE BIRDS

In 1926 the Oropéndolas began to build on January 8; in 1927 they began on exactly the same date; and in 1928 on January 2. There was, therefore, less than a week's variation in the commencement of their building operations, and their year was thus approximately the year of our calendar. This regularity seems to me a matter of exceptional interest. In our strongly-marked seasons we take it for granted that the annual recurrence of various phenomena, such as the flowering of plants and trees, return and nesting of birds, are more or less closely controlled by climatic conditions, particularly temperature. But on Barro Colorado the temperature is much the same the year around. The mean temperature for July in Panama is 81.1°; for February, 80.8°, a difference of only three-tenths of a degree. The year, then, is not seasonally divided by variations in tem-

[1] Vol. LVIII, 1929, pp. 123–166.

perature but by the amount of rainfall—as has been elsewhere remarked—into a dry season and a wet season. Some birds nest in one season; some in the other. The Oropéndolas are dry season nesters; and I think that this is true not only of the Panama species, but also of the fifteen other members of the group.

But even in only three years our island rain-gauge showed a variation of a month and six days in the dates when the dry season began. Thus, in 1925 the rains ended on December 6, but in 1927 not until January 12. But this variation did not influence the Oropéndolas. Each year, as we have seen, they began to build at about the same time. Without definite and regular changes of temperature, rainfall, or vegetation to guide them, how did they know when to begin? The answer is that each bird carries its calendar within itself. Technically it is known as a physiological cycle in which the events of the bird's individual year follow one another in orderly and periodic succession. Just as a tree buds, blooms, leaves, fruits, sheds its leaves, rests, and, in due season, repeats these expressions of its cycle, so a bird mates, builds a nest, lays, incubates, rears its young, molts, and then, like the tree, after resting, at the proper times these phenomena are repeated.

It is, then, an inner prompting that tells the Oropéndola when to come to Laboratory Hill, and it is

exactly the same kind of impulse that, in March, induces the Bobolink to leave his winter quarters in Argentina for his summer home in Massachusetts; and starts the Bay-breasted Warblers, which winter on Barro Colorado, northward at a date when their summer homes are probably still snowbound.

The only difference here between the Oropéndola and the birds that go far north is in the length of the journey. Functionally the Oropéndola is just as much of a migrant as the Bobolink or Warbler. All go to a certain place at a certain time to build their nests and rear their young. The Oropéndolas may spend their lives on Barro Colorado, but to try to explain why they should travel perhaps only the width of the island, while the Bobolink and Warbler journey thousands of miles, would take us far from the sandbox tree. At any rate we have seen that although a tropical bird may, as a species, be permanently resident in the same region, it may, fundamentally, be as much of a migrant as a bird that goes from the equator to the arctic circle. To this extent the Oropéndola throws some light on the object, and hence the origin of bird migration.

THE SELECTION OF A NEST-SITE

Just as in the Temperate Zone migrant birds do not begin to build until some time after their arrival,

so the Oropéndolas came to Laboratory Hill as much as two weeks in advance of their actual nesting-date. As with most Temperate Zone migrants, the males came first; theirs is the stronger urge, and from the nest-tree they loudly announced their presence. Several days later a female or two arrived. Both sexes remained only a few minutes and showed no interest in one another. As the date of building approached, the birds came in larger numbers and stayed longer. While the sexes were sometimes together they were not associated. The males attempted to address the females but were completely ignored. The females, indeed, seemed unaware of their existence and devoted their attention solely to the selection of a nest-site. This is a matter of the first importance. The pendent nest of the Baltimore Oriole and cup of a Vireo are suspended from the fork of a twig, but the Oropéndolas use only a single branch. It should, therefore, offer a suitable base for the attachment of the nest foundation; it should permit the nest to swing clear, both below and at the side; it should be strong enough to support the weight of the parent and its young and, at the same time, withstand the force of the trade winds. The males had no voice whatever in this matter, and the females, as though aware of the responsibility which they must bear alone, examined the possibilities

carefully before making a choice. Each one seemed to be afraid that some other bird would find the best limb. They followed each other closely through the tree in groups of five or six. If one bird left the group to examine a branch in another part of the tree, the others all hurried after her. The spirit of competition ran high and it not infrequently resulted in actual combat. This was no make-believe affair. The birds locked claws and, fighting bill to bill, whirled downward on spread wings until they almost touched the earth. Then they separated and, yellow tail-feathers showing, flew to a nearby limb, sat there side by side for a few seconds when, the little misunderstanding having apparently been adjusted, they rejoined their comrades and resumed their site-hunt.

Most of the birds nested in small groups of six to ten or twelve individuals. When all the members of a group began to build at the same time there was comparatively little competition over the site. The birds seemed to be on friendly terms as though they had known each other for some time and perhaps had even nested together before. Within two or three days their differences were arranged, the sites were selected, and building operations under way.

But when a bird was apparently nesting for the first time and had selected a site which was also wanted by an entire stranger, the matter of owner-

ship was not so quickly and amicably settled. In one instance six days were required to reaeh a deeision. During this period the two elaimants devoted their time wholly to discussion, often punetuated by eombat. These birds were first observed at 7.35 on the morning of January 19, 1927, facing each other on site-twigs about one foot apart. One was addressing the other and so earnestly that, although the birds were of the same size and their voiees were not loud, I supposed I was witnessing a eourtship seene. The bird addressed with lowered head listened intently. But, behold! when the speeeh was finished, she "took the floor" and replied with equal vigor while bird No. 1 assumed the listening pose. Developments proved that both were females, and for the first time I learned that this sex had a voeabulary of its own. So day after day the diseussion was continued. Both birds were never seen talking at the same time and the bird addressed gave her entire attention to the speaker. But there were times when Oropéndola nature could bear no more; the attitude of respect was abandoned, the birds sprang at each other, grappled, and, fighting, whirled earthward. This outburst seemed to relieve them and it was at onee followed by the dignified attitude of discussion. Whether a deeision was reached, a truee declared, or a compromise effected

I never knew, but on January 25 each bird began a nest on its own perch. It then appeared that both were inexperienced builders.

Thus far the question of a mate had apparently been given no consideration whatever. The males

The bird addressed gave her entire attention to the speaker

were present and obviously eager to be heard and seen. But their somewhat ponderous style of courtship demands a fixed point of address to be displayed impressively, and the females were too much interested in what they seemed to consider their own affairs to have either ears or eyes for the vociferous attitudinizing of the male. Of his continued interest they seemed assured. Was it possible that in some way they realized that in due time their "cycle" would make them responsive to his appeal? Mean-

time, unaided, they proceeded industriously with their preparations for the housing of the prospective family. Every morning at sunrise the males sang from the sandbox tree as though calling them to their labors. The females arrived about twenty minutes later and for the succeeding four hours worked steadily. They were confronted by a difficult task. Their close-woven bags, about three feet long, are among the most elaborate pieces of bird architecture and can be constructed only by rarely skilful needle-workers. The material must be strong and pliable; tendrils, rootlets, plant-fibers, filamentous blossoms, and strips of bark were used. The foundation must be so tied to its single twig-site that the opening, or door, will be properly formed and at the bottom, where the true nest is placed, the bag should be so expanded that there will be room for the sitting bird.

BUILDING THE NEST

The birds had not far to go for their material. The neighboring forest offered it in abundance. Usually they went out to collect it in small companies. There was more than enough for all; but some birds could not resist the temptation to help themselves nearer home. In the absence of a neighbor they pulled loose strands from her nest, undoing in a minute an hour's work, then hurried with their booty to their own nest.

This habit was unequally developed; in some birds it was wanting, in others almost chronic. Slovenly builders were more apt to be robbed than those that left no loose and tempting ends about their home. There was a limit, however, beyond which it did not pay to try to rob another bird's nest. Only the partly woven ends could be easily taken; after that the robber might tug and pull, adding her weight to her strength, but she got little or nothing for her pains.

The art of nest-building focuses about the making of the door. It might indeed be said that the bird makes a door and then builds a house about it. Usually the foundation fibers are woven downward until they form a flat piece or apron ten to twelve inches in length. In the lower part of this an opening three to four inches in diameter is made and the base of the ring or loop thus formed becomes the sill of the doorway. This is strengthened by the use of additional material and closer weaving. As soon as the ring is completed the bird stands in it, weaving first above and then below. From this stage downward she works inside the lengthening bag, which is evidently formed about her body as a mold.

Even when the long sack is nearly complete, but is still open below, the builder leaves and enters the nest by way of the door. Entrance is made on the wing with, as the nest is approached, a slight down-

ward dip followed by an abrupt upward turn which serves to check the speed of the bird's flight. The bird thus flies into her nest without pausing on the threshold. The regularity with which this procedure is followed is an indication of its importance. With its back exposed and head concealed, a bird, perched at the nest-opening and looking in, would evidently be at the mercy of a foe from without, and this point of exposure is, therefore, passed as quickly as possible. When leaving the nest, however, the position and the conditions are reversed and the bird often perches in its doorway and leisurely surveys the surroundings.

The use of the nest-opening from the day it is available trains the bird's sense of location. I have never knowingly seen a bird make the mistake of entering the wrong nest, even when, as is often the case, several are near together. Under normal conditions it is, indeed, rare for a bird to exhibit the slightest hesitation in finding her own doorway. Changes, however, may occur which for a moment tend to confuse her. For example, when the nest swings widely in a high wind not only is it in motion but the actual position of the opening is altered and both factors cause the returning bird to hover for a second or two before slipping into it.

There is a wide variation in the nest-building

ability of different birds. This is probably in part individual but it is doubtless also a measure of the extent to which their instinct has been developed by experience. Some birds evidently know exactly what they want to do and work rapidly and effectively; others show but little interest in their work and seem at a loss to know how to use the material they have collected.

The members of Groups 1 and 2, of the season of 1927, illustrated, respectively, these extremes. The first formed an organized group of birds that had been, apparently, associated before, and hence, presumably, were more or less experienced. The second group was composed of birds that had not established communal relations and some of which, at least, seemed to be building their first nest.

Group 1 began building on January 8, and for that day my record reads: "Seven females came back from the forest together bringing green tendrils. Some work at old, some at new sites. The first tendril is attached to the limb skilfully and rapidly. It is put over and under, pulled here and poked there. They work feverishly but definitely. Their heads go over a limb with a tendril and then reach under it to get the end and pull it through. No needle-worker could proceed with less hesitation." These birds showed their earnestness by working in the rain.

On January 9, my journal reads: "A thoroughly rainy morning, with showers and thunder; the whole sky overcast. I see twelve females and one male in the field of my 24-power glass. The females are using some fiber and all work furiously, about one-half on old sites, the rest on new. There is very little confusion and each bird 'sticks to its own knitting.' . . . They thrust over and pull under without apparent study and without waiting. Each one seems to know exactly what she wants to do and goes at it like a master workman absorbed in her task."

The same concentration and effectiveness was shown by this group throughout the period of construction. On January 22, the entry reads: "These birds work whole-heartedly, with strict attention to business, rarely coming into contact with one another. Sometimes a head appears through a nest-bottom pulling vigorously at a fiber here or poking in a loose end there. Position is a matter of indifference. They work upside down or right side up; nor do feathers of wings or tail impede their movements. The tail may be bent any way, the wings closed or half-spread. They are intent on only one thing and are not concerned with appearances."

Compare with these extracts the following, describing the nest-building efforts of birds Nos. 1 and 2 of Group 2. We have already seen that these birds

devoted six days to discussing the nest location before work actually began. I quote from my notes:

"January 24, 7.53 A.M.—No. 1 returns with short brown fiber but doesn't seem to know what to do with it. After a half-dazed moment she weaves it into foundation . . . . 9.05, No. 2 returns with a bill full of green tendrils but loses three-fourths of them. No. 1 comes with a bill full of the same kind of material; they fight and she loses all of it.

"January 25, 8.14 A.M.—No. 1 sits with a straw in her bill, motionless until 8.23 when she uses it.

"January 29, 8.05 A.M.—No. 2 is still trying to form an opening—the doorway—but it will not take shape. She pokes and pulls and weaves but apparently lacks sufficient experience to succeed. She can weave but she doesn't seem to know what to weave.

"January 30, 8.30 A.M.—No nest in Group 2 has a completed opening, and only No. 2 has attempted to make one. All the facts observed suggest that these are young birds making their first attempt at nest-building, in which case their instinct must develop slowly with experience.

"February 7.—No. 1 has broken the bottom of her ring and works with wide-spread feet grasping each end of it. No. 2 has deepened her saucer but has not yet a doorway.

"February 10.—No. 1 still struggling with her en-

trance. No. 2 has completed hers and can now get inside the beginnings of a bag.

"February 14.—No. 1 has brought the loose ends of her doorway together and is almost concealed when at work."

The time required to weave a nest-bag depends chiefly upon the experience and skill of the weaver. It averages three to four weeks. Then the real nest is placed in the bulbous bottom of the long, swinging pouch. It is composed of nearly a hatful of fragments of soft leaves and bark, and short pieces of fiber. This is not shaped into a circular nest with depressed center and surrounding walls, but is a formless bed, probably designed to prevent the eggs from breaking when the nest-bag is violently blown about by the strong trade winds of the dry season.

COURTSHIP

Through the entire nest-building period the female continued to ignore the existence of the male. If he were a bird of another species she could not have seemed less aware of his presence. But he was not easily discouraged. The female's labors now held her to a given place for a long enough time to enable him to pay his ardent and elaborate devotions. Taking a position above where she is at work, he leans down toward her, his blue eyes glare, his crest-

feathers are elevated and expanded laterally, his wing-tips are crossed above his tail, and the fluffy feathers of the lower back are spread out over the inner edges of his wings. He is obviously moved by deep inner feelings which demand expression. He begins visibly to swell, his tail is nervously twitched and spread, his body-feathers are fluffed, he rises on tip-toe in the effort to give voice to emotions that seem about to choke him; he splutters, chucks, cacks, gurgles deeply, liquidly, and is finally delivered of a violent crashing ejaculation just in time to save him from a more serious explosion.

Deflated, relieved, he sinks backward; but only for a moment. Again he begins inwardly to ferment; again he visibly swells; again, with a gurgle and a splash, he blows off his vocal safety-valve. Hour after hour, day after day, week after week without apparent loss of hope but with no sign of encouragement, the inspired wooer presses his suit. Unmoved by his heroic exhibition, the female continues weaving steadily or flies back to the forest for more material. In the latter event the male closely follows her both in going and returning, but never once does he carry so much as a rootlet or help in the weaving of the nest. His interests are in her; in her home he never even puts his bill.

Long before this it had become evident that the

colony contained at least six times as many females as males. The discovery of this unexpected fact raised a number of questions concerning the marital relations of Oropéndolas. The excess of females might lead one to believe that they were polygamous; but polygamy, among other things, begets a complicated set of domestic relations difficult to maintain. It seemed more likely, therefore, that promiscuity, or what might be called coöperative polygamy, would prevail. Observation proved that neither assumption was correct. The Oropéndolas have a system of their own.

With the house built and furnished, the time had come to complete the family circle, or one may with equal truth say the family cycle. Courtship was now the order of the day. The female, who had heretofore been merely a weaving-machine, now became a responsive, affectionate feathered creature. The attentions of the male were not only accepted, they were returned. Perched by his side she gently picked at his head or ran her bill through the feathers of his crown, a caress he gratefully welcomed, and deserved. For several days the pair were inseparable. He followed her like a shadow, his rights undisputed by any other male. He still sang, but with comparatively little ardor. The prize had been won, why continue to clamor for it? Evidently during this

period the eggs are laid. Again the cycle advances. With the deposition of the eggs comes the need for their incubation. This task the female performs alone. The household no longer has room or need for the male, and with the end of the honeymoon the marriage relation is terminated. She proceeds with her family duties and he is free to seek a new mate. It appears, then, that Oropéndolas practice a limited monogamy. Could any method more admirably, more morally, meet the conditions nature has imposed upon them? If a male should devote himself to but one female throughout the nesting-season it is clear that five out of every six females would be without a mate. Under the existing custom each female has not only a home but a family, and the continued existence of the species is assured. It is doubtless part of this plan that prompts the females to nest in small groups, beginning at different times, thus enabling the male to devote himself to one wife at a time.

With the arrival of the incubating period, the nest makes a fresh claim on the attention of the female. Like the housewife of the rhyme, her mate's day is from sun to sun but her work is never done. She no longer goes to the forest to roost but now sleeps in the nest. The gathering in the nest-tree now becomes a nightly habit. Even the birds whose nests are not

ready for occupation stay in the tree until those whose homes are completed enter them. All sit about industriously preening their plumage—making their toilet for the night. At about 6.15, or about ten minutes before sunset, the first female enters her nest. Her example is soon followed by others and by 6.30 all who are to stay have gone to bed and the remainder fly to the forest. It is a summary way of disposing of guests.

Even my 24-power binoculars were not strong enough to tell me what was taking place at the bottom of the close-woven sacks at least eighty feet away. But from evidence of various kinds, including many records of exits and entrances, and the contents of several fallen nests, I concluded that the period of incubation is about seventeen days. From the fallen nests and the observations of others I also learned that but two eggs are laid. This small number is in conformance with the law that tropical birds lay a smaller number of eggs than their representatives in the north. As we have already seen, even the irrepressible House Wren is subject to this law. Whatever may be the underlying physiological reason for the Oropendolas' small family, it is fortunate for the female that during the thirty or more days the young are in the nest she has two to feed instead of four.

As a rule, the Oropéndolas were on excellent terms with each other. Beyond their little disputes over a building-site, the females had no observable misunderstandings. Although such ardent wooers, the males exhibited but little sexual jealousy. Doubtless if the ratio of males to females had been reversed competition for a mate would have been correspondingly keener. When several males (I have seen four) court one female at the same time the situation is apparently threatening. The birds whine excitedly and an attack seems imminent, but at the worst it results in a pursuit, with one bird retreating slowly before the other, flying from limb to limb but usually not leaving the nest-tree. No notes are uttered—the whine seems to be the only battle-cry; there is no resistance and hence no fighting, and the whole affair is quiet and orderly.

If the Oropéndolas were on as good terms with the world as they are with each other they would be an overpowering success. They seem hardy, vigorous, and strongly organized; the young examined were practically free from parasites; their nests, placed at the bottom of deep, firmly woven bags swung from the tips of slender twigs, seemed exceptionally safe receptacles for the eggs and young. From these facts alone one might expect that Oropéndolas would overrun the island, if not the tropics. But besides the

laboratory colony I know of only two other nesting-groups on Barro Colorado. Why are there not more? Certainly there is no lack of either nesting-sites or food. The birds are not exposed to the perils of long journeys but spend their lives under favorable climatic conditions. What, then, are the factors that keep the Oropéndolas in their place and permit them to hold their own—but no more? To discover them would be the most interesting and significant part of my study. The search for this information took me from the Oropéndolas' Bureau of Domestic Affairs to their Department of Foreign Relations.

THE OROPÉNDOLAS' ENEMIES

It was soon apparent that whatever advantage the Oropéndolas enjoyed from the position and character of their nests was fully offset by the exposed situations in which they nested. A bird's world is too full of dangers to permit it to be long off guard without sooner or later paying the penalty. When on their nest-sites the Oropéndolas are large, conspicuous objects. While at work their back is often to the sky and until they begin to weave from within, which they do at the earliest possible moment, they are especially susceptible to attack by Hawks. When this fact was realized it also became evident that the male was not only a wooer but a watchman. It was

his duty to keep an eye on the sky and at the slightest indication of danger sound the alarm-note—a loud, excited, rapidly uttered *cack-cack-cack*—a true watchman's rattle.

The response to this signal is variable. At times the whole colony, as one bird, dives precipitately into the lower growth of the adjoining forest to remain there until the danger, real or fancied, is past. I have seen a bird while flying toward the nest dodge abruptly downward in the air when hearing this alarm-note. At other times, although the warning evidently puts the birds on their guard, they do not move when it is given.

Turkey Buzzards do not, as a rule, evoke this call, and generally Ghiesbrecht's Hawk, a pair of which lived near the laboratory, was permitted to pass unchallenged. But at times even the appearance of these birds, more particularly the latter, was the occasion for an outcry and the accompanying downward rush to cover. Rarely, a low-flying airplane created alarm. Often the warning cry was given without apparent reason but its cause may have been clear to the birds though unseen by me. Possibly, also, it may have shades of meaning to which human ears are deaf. It is, however, understood by other birds. I have seen Toucans, Caciques, and small Flycatchers dive with the Oropéndolas.

One day, at noon, when the vigilance of the males may have been relaxed, the expected happened. Death, in the form of an Eagle Hawk, fell from the sky, struck an Oropéndola at work on the foundations of her nest, bore her to a nearby limb and, later, to the forest. This event caused tremendous excitement among the Oropéndolas, their united cries of alarm producing the effect of a loud chorus. They all left the tree and for the remainder of the day the colony was completely disorganized.

The following day the effects of this catastrophe were still evident in the nervousness of the birds and the frequency with which the alarm-call was uttered. Normally this call may be heard three or four times during a morning, but during two hours on the morning of February 13 it was given at 8.50, 8.51, 8.55, 9.04, 9.07, 9.10, 9.12, 9.22, 9.40, 10.12, 10.15, 10.26, 10.44, and 10.50, a total of fourteen times in two hours. Excepting two Buzzards that flew over at 9.10 and 10.44, respectively, no cause for alarm was seen by me during this period. The first seven times the alarm was sounded all the birds responded promptly, diving to the protection of the lower growth. Later their reaction was not so keen and to three out of seven signals they did not respond.

The incident illustrates the exposure to attack by a predatory bird of an Oropéndola working outside

her nest, the need for a guard, the importance of prompt obedience to his warning, of the quickening of reactions through experience, and of their decline after frequent call had been made upon them.

If the birds themselves are open to attack it might be imagined that at least the contents of their long nest-bags are immune. They can doubtless be reached by tree-snakes, though I have no evidence of their being preyed on by these, or by other reptiles. Possibly Marmosets may be able to approach them, but we have never known them to do so. Furthermore, any diurnal enemy would doubtless be subject to attack from the sharp, strong bill of the female, and perhaps also of the male Oropéndola. It is, however, a nocturnal winged foe that proves to be one of the most serious enemies of the Oropéndola. This statement is based on observations made on Group 1, 1928, and recorded in my journal for January 25, as follows: "7.30 A.M. Some mishap has befallen Group 1 (containing 8 nests) during the night. Nest No. 3 is hanging upwind across the lower part of No. 4, and has a large, round hole in the bottom, evidently made from without. No. 5 has a similar opening. Nos. 2 and 4 each have a small round hole in the side near the bottom. I showed these nests to Donato who at once said: 'El buho' (local name for *Pulsatrix perspicillata*) and added that, early one

morning in the preceding year, he had seen an Owl fly from its perch in the dead tree adjoining the sandbox and pick at the Oropéndola nests. Certainly whatever did this work had wings."

The Owl named is seen or heard about the clearing nightly. Donato is a careful observer, and it is probable that his identification of the marauder is correct. All the nests mentioned were begun on January 2 and it is possible may have contained eggs, though I had no record of the birds sleeping in their homes. The owners of Nos. 2 and 5 returned to their homes and were evidently incubating as late as February 3.

Apparently the attack of the Owl or Owls created a condition which made the remaining birds in the group more susceptible to persecution, and eventually the whole group-site was abandoned. On former occasions I had seen holes an inch and a half in diameter at the side of the nest-bag, about on a level with the nest, and supposed that they were made by the owner; but if they are made by the foot of an Owl reaching in while clinging to the nest, it is evident that the home of the Oropéndola is far from impregnable.

CASSIDIX, THE COWBIRD

The victim of Hawks by day and Owls by night, the Oropéndolas might be thought to have their

share of enemies; but these are foes that attack from without; we have still to hear of two that prey from within. One of these is the so-called Rice Grackle, a large Cowbird of the genus *Cassidix*.[1] The other is a small Flycatcher of the genus *Legatus*.[2]

At the proper season Cassidix visits the sandbox tree to deposit her eggs in the nests of the Oropéndola. Legatus resides permanently in the colony and, in seeking to gain possession of an Oropéndola nest for her own uses, so distributes her annoying persecutions that she becomes a community affliction.

All bird-students are familiar with the habits of our northern Cowbird,[3] but few indeed are those who have caught her in the act of depositing her egg in the victim's nest. She seems properly ashamed of herself and takes every precaution to avoid being seen. Not so Cassidix. There is already a Cowbird known as the Bronzed Cowbird, but Cassidix should be called the Brazen Cowbird, for certainly nothing could be more brazen than the manner in which she enters the Oropéndola colony. Her first visit is made not long after the nests are started, evidently just to see how affairs are progressing. Although it is clear that she is then merely making a reconnaissance, she is at once recognized as an enemy. No alarm-note is sounded, but all the Oropéndolas join forces in

[1] *Cassidix oryzivora.* [2] *Legatus leucophaius.* [3] *Molothrus ater.*

driving out a common foe. Even Legatus sees in Cassidix a possible competitor and takes part in the chase; while the little Black-throated Hummer joins in the pursuit on general principles.

Cassidix, however, goes when she gets ready. If her tour of observation is not completed she flies from limb to limb. If she is driven from the sandbox tree she circles and at once returns. When, finally, she has acquired all the information she desires she takes leave on what promises to be a long flight. Sometimes she heads out over the lake and is lost to view. Similarly, when she arrives, she seems to have come from a great distance.

The fact that Cassidix selects the Oropéndola as a foster-mother is not new. Cassidix, the Oropéndolas, and their smaller cousins, the Caciques, are all found throughout the tropics, and apparently everywhere Cassidix places her eggs in their nests. Indeed she is not known to patronize any other nests. If, then, her choice is so restricted, she must be thoroughly posted in regard to the location of the Oropéndola and Cacique colonies in her territory and have the most recent information regarding their stages of development. It would be useless to deposit eggs in the nests of birds not prepared to receive them; it would be equally inadvisable to deposit them with well-advanced eggs of the Oropéndola.

Unless, therefore, Cassidix can control the development of her ovaries, she must either waste eggs or know where to place them to advantage.

When I saw Cassidix coming boldly into the sandbox tree I always thought of her as possessing a notebook in which she had entered data concerning all the Oropéndola and Cacique colonies within her local range. How else does she possibly time her visits so that she will reach the right place at the right time?

Coming from afar she perches near the top of the sandbox and surveys the colony. By some uncanny instinct she selects her nest and then by short stages makes her way toward it. But there are too many eyes in the colony and the birds nest too near each other to permit her to escape observation. Several fly at her but, if her needs are pressing, she is not to be denied. She dodges, twists and turns, fights back if necessary, until she actually forces her way into the desired nest and presumably accomplishes her purpose.

What effect the imposition of Cassidix has on the death-rate among Oropéndolas is unknown, but it is evident from their actions that she is an exceedingly unwelcome guest. Any other non-predatory bird is permitted to enter the nest-tree without question. My notes record visits from over fifty such species, but the moment Cassidix is discovered they rally to attack her. They do not act without reason.

LEGATUS, THE FLYCATCHER

A week or more before the first Oropéndola nests are finished a small Flycatcher appears in the colony. He is an inconspicuous looking bird, dark olive-green above, whitish or yellowish white and streaked below, and about the size of our Phœbe.

Taking a position on one of the higher branches of the sandbox he calls a high, sharp, penetrating *pee-ee*, often adding *teedle-dee-dee*. There will be but few minutes between sunrise and sunset during the remainder of the nesting-season when this call cannot be heard. In a day or two he will be joined by another bird who adds her voice to his. There is no sexual difference in color, or, as far as I could learn, in notes in this species, and the use of the personal pronoun is therefore provisional.

The Oropéndolas do not resent the presence of these two little birds; indeed they pay no attention to them, but if I am any judge, they are far more to be feared than Cassidix. She is in and off again while you watch her, but Legatus, as this small bird is called, is an ever-present pest.

For several days they continued merely to perch and call. They were never seen to feed near the sandbox tree but at rather long intervals dashed to the forest, evidently got a bite, and within a minute

returned to resume their interminable *pee-ee-teedle-dee-deeing*. They arrived in the morning within a minute or two after the first Oropéndola called; in the evening they remained until the Oropéndolas retired. Finally, they revealed their object. They wanted an Oropéndola nest! Laying aside all the question of principles, one could not but admire their taste. The nests of the Oropéndola are undoubtedly better than any they could build themselves; but when one compared the diminutive Flycatchers with the giant Orioles, there seemed small prospect that their ambition would be gratified. But mere size is not the most important factor in achieving one's ends. Persistence carries one much further; and the persistence of Legatus would have conquered an Eagle, not to mention an Oropéndola.

After a general attack on the colony at large, including even the ponderous males, they selected their victim, choosing a nest rather apart from the others. Its owner might better have capitulated at once; it would have saved her much time and endless annoyance.

The tactics of Legatus are: avoid all frontal attacks and harry the flanks of the enemy. Imagine the surprise of an innocent, unoffending Oropéndola who, when leaving her doorstep, is attacked by two agile, winged creatures who dart at her, first from

one side then from the other, so viciously that there is safety only in flight. If she tried to explain this surprising assault she may have considered it a case of mistaken identity. Certainly she had done nothing to warrant such treatment. But when she returned there were her assailants waiting for her, and she had to fly the gauntlet of their blows before she gained the protection of her home. Day after day this was continued. To leave her nest without being attacked she had to watch her chance and then fly for it. Often she was prevented from entering it and sought the shelter of nearby leaves to wait for an opportunity to slip in unobserved. At times, evidently exasperated beyond the limit of endurance, she turned on her annoyers and pursued them around and around the tree. On one occasion I saw them make the circuit of the tree ten times; but while she vainly chased one of her persecutors the other one chased her!

Finally she seemed to realize that her case was hopeless and abandoned her nest. Meanwhile, Legatus had been examining it from the doorway. Perching at the edge of the opening, one would peer in, twitter excitedly, nod its head this side and that, and then retreat to its perch. Gradually they ventured farther and remained in the nest from two or three to thirty seconds. Presumably they had

now accomplished their object and peace would reign in the sandbox tree. But, either because the nest was not to their liking or may have contained eggs of Oropéndola, or possibly because they were still possessed of the spirit of combativeness, they rejected their prize and sought a new victim. Then with the same fiendish persistence they made the life of another Oropéndola miserable.

For two seasons, with undiminished energy, the Flycatchers continued to wage warfare on the helpless Oropéndolas. When they found time to raise a family of their own is a mystery. Determined to solve it, I devoted quite as much time to the small birds as I did to the large ones. At last, on February 11, of my third season, it seemed apparent that Legatus had actually decided to settle down. My notes for that day read:

"It looks as though the Legatus puzzle had finally solved itself. At 12.45 I chanced to see Legatus enter No. 5, Group 1. On emerging, after four or five seconds, she left the tree and at the end of about two minutes returned and entered No. 5 again. Having my glass now turned on the nest I saw that she carried something in her bill. Moving with my 24-power glass to the end of the laboratory, I saw, when some two minutes later she reëntered the nest, that she carried what appeared to be a small bit of a

A Parasitic Flycatcher

The Flycatcher (Legatus) builds in an Oropéndola nest after evicting its owner. The nest here shown is from a photograph; the Flycatcher was drawn by F. L. Jaques.

(Courtesy of The American Museum of Natural History)

A Group of Oropéndola Nests

The pair of parasitic Flycatchers (Legatus) is near the center of the picture

The Fallen Sandbox Tree

Note the figure of Donato at the right of the papaya

brown leaf. She entered the nest so quickly, however, that I could not be sure of the exact nature of her burden, but two visits later she brought an entire leaf perhaps three-fourths of an inch long. It seemed evident, therefore, that she was building a nest. I say 'she' for the one that remained outside, perching within a few inches of the nest-opening, called constantly and greeted the builder with vociferous, excited twitterings on her return. During the succeeding twenty minutes ten visits were made by the female, each time with building material. Only twice during the succeeding four hours did the Oropéndola appear. Once she swept down as the female Legatus was about to enter, and at 3.55, while the female Legatus was in the nest and the male at its door, she came with the apparent intention of entering but retreated quickly before the fury of the Legatus attack. Half a minute later the female Flycatcher continued her work." Thereafter Legatus was left in undisturbed possession of this nest. It may be noted that my records now showed this nest to have been visited by Cassidix, attacked by Owls and claimed by Legatus.

For the succeeding seven days Legatus continued peacefully to occupy, or at least to frequent, this nest No. 5 of Group 1, but February 19, to my surprise, both birds were seen fiercely attacking nest No. 2

in Group 2, fully forty feet above No. 5 of Group 1. They perched at the entrance to the nest, fluttered excitedly, and peered within just as though they were prospecting for a home.

The bird I assumed to be the female was often seen sitting near the entrance to the nest preening her plumage and disclosing the wide bare parting from breast to vent which bespeaks the incubating bird; then she would enter the nest while the male sat nearby calling.

Everything now looked regular and stereotyped. The young might be expected to arrive any day. But on the night of March 23, the twig to which the nest adjoining the home of Legatus was attached broke and the nest fell to the ground. It was found to have the round hole in the side, at the inner nest-level, that I believe to be made by an Owl. There was not sufficient wind to account for the breaking of the limb, and I attribute the mishap to the weight and movements of the nocturnal marauder. Of more importance is the fact that the nest occupied by Legatus had also been punctured. The actions of the birds indicated that something unusual had occurred. He fluttered excitedly at the nest-entrance but did not enter. She preened, showing the bare abdomen, and went into her home. Later she joined the male and for the first time in almost two

weeks added her voice to his. She seemed reluctant to return to the nest, and the male attacked her. This was unprecedentcd. Twice he stood over her with fluttering wings while she hung, belly up, below him. I saw no blow struck or peck given, but the attitudes were those of offense and defense. At 11 A.M. the female entered the nest; but at 4 o'clock this afternoon (March 24) when the male Legatus attacked an Oropéndola that alighted on the nest, the female, for the first time, failed to appear in response to his battle-cry. Nor was she or any other female seen for the succeeding three days. Apparently she had deserted her mate and her home. Meanwhile, from a perch in the top of the sandbox the male called valiantly and not in vain. On the morning of March 28 a female of his species appeared. Apparently she was not his lost mate. Her plumage scemed fresher, less worn, and when, infrequently, she preened her feathers those of the abdomen did not part widely and disclose the bare skin. The male chased her and evidently tried to interest her in several abandoned Oropéndola nests. He did not, however, take her to No. 2, his former home, nor was she seen to enter it. But he was unable to win her. She remained only a day, and on March 29 the male resumed his call for a partner. At the end of three days, when I left the island, he was still

calling, and I have no doubt that he continued to call until he was answered.

How insignificant his mere dot of a body looked when compared with the black bulk of an Oropéndola's! How petty and ineffective his ridiculous *pee-ee-teedle-dee-dee* sounded when heard with the Oropéndola's explosive crash! Who would have imagined, even when seeing and hearing the two birds in the same tree, that this insignificant little green Flycatcher could be one of the important influences in limiting the numbers of a species apparently as well prepared to contend with the unfavorable forces of its environment as the large, strongly organized Oropéndola? And when we add to Legatus such other enemies of the nesting-period as Cassidix, Hawks, and Owls, it is evident that even without the casual misfortunes to which at all times they are exposed, there is no immediate danger of Oropéndolas becoming unduly abundant.

POSTSCRIPT

We have seen that the tree occupied by the Oropéndolas when the laboratory was established contained, when it fell on June 26, 1925, fifty-seven nests. The following year, 1926, the first season in the sandbox tree, the colony contained, when I left the island February 26, thirty-nine nests. In 1927

the number on April 2 had fallen to twenty-nine. In 1928, after sixteen nests had been built, the colony was abandoned under the combined attacks of Cassidix, the Owls, and Legatus. On August 28 of that year the sandbox tree was blown to the ground and the birds have not returned to the vicinity. So ends the history of the Oropéndolas of Laboratory Hill.

But Legatus was not so easily discouraged. Occasionally in February, 1929, I heard their familiar note, but it was not until the 26th of the month that a male was found who appeared to have established himself in the upper branches of a tree at the border of the clearing and about a hundred feet north of the site of the sandbox tree. Some time before March 11 he secured a mate. I watched the two birds closely but they showed no especial interest in their surroundings, and beyond catching an insect or two at long intervals seemed to have nothing to do but call. They were, however, merely biding their time. On March 24 I heard the rapidly repeated, excited *dee-dee-dee-dee* which is the battle-cry of Legatus, and found the two birds attacking a pair of Cayenne Flycatchers that had just finished a nest (perhaps two nests) in a small orange tree in the clearing northeast of the Shannon House. They had chosen exactly the proper time to make their claim—when their

victims' nest was ready for occupancy and before an egg had been laid.

It now seemed obvious that Legatus did not confine its unwelcome attentions to the Oropéndola. The nest of the Cayenne Flycatcher is not pendent but is composed of a large mass of fine grasses, with the opening on the side. It is, therefore, covered and the eggs consequently are concealed as they are in those of the Oropéndola. Hence there is sufficient resemblance between the structures of the two species to make the nest of either acceptable to Legatus.

The poor Flycatchers seemed defenseless. Perched side by side in a nearby tree, they fluttered their wings and twittered dolefully *clear-a-way, clear-a-way.* But Legatus did not "clear a way," and whenever the Flycatchers ventured near their nest they were set upon with so much vigor by Legatus that they quickly retreated and, at the end of the day, they seemed to have deserted the locality.

Meantime Legatus, exhibiting the same old tactics, peeped first in one nest then in the other, as though she could not make up her mind which one to choose. Neither was above my head and I hoped now actually to *see* what transpired in the stolen home of this remarkable little Flycatcher. But no sooner had the birds acquired possession of the nests than they seemed to lose interest in them; and the following

day they had returned to their look-out in the tall tree at the border of the forest, distant about 200 feet. Here they remained for two days when again I heard their battle-cry and, as before, I found that they had selected a pair of Cayenne Flycatchers for their victims. The nest of these birds, situated about 100 feet from the home of the first pair, and also in an orange tree, was recently completed and ready for occupancy but still empty. Unfortunately, its fate was not decided when, at this time, I left the island. After four seasons' observation I have, therefore, still to discover how Legatus perpetuates its kind.

CHAPTER V

TWO WIDOWS OF THE SANDBOX TREE

ALTHOUGH the marital relationships of Oropéndolas do not conform to Victorian standards, the males are at least tireless, ardent suitors and ever-present, vigilant watchmen. But the husbands of Natterer's Cotinga and the Black-throated Hummingbird that nested in the sandbox tree were never seen to put foot on its branches. In selecting the home-site, the females had to rely entirely on their own judgment, and the safety of their families, as well as their own lives, might depend upon the care and foresight they used. Alone and unaided they gathered the building material and fashioned it into a structure which would serve as incubator and cradle. Up to this time doubtless both birds had mates somewhere in the forest, but once the eggs were laid it is probable that they were truly widowed, and with no encouragement whatever from their one-time partners they were left to hatch the eggs and meet the problems of maternity as best they could. Herewith is a partial record of their lives at this trying period.

The Cotinga

If the great butterfly, Morpho, is the bluest thing in the world, the Cotingas may claim to be the bluest birds in the world. But where the butterfly flits along the trails and forest borders freely displaying its matchless color, the bird remains in the tree-tops where even the ornithologist rarely sees him. One's first Cotinga is an event long anticipated and forever memorable. Mine was an unknown, apparently black object, about the size of a Kingbird, in the branches far above my head. I fired, it fell, and from the forest floor I picked up "a little bit of heaven." I have never killed another.

My first female Cotinga was seen on Barro Colorado. While the male is brilliant cerulean blue with black, blue-edged wings and tail, deep purple throat and median breast-line, the female is brownish black above with just a tinge of blue, and the feathers are so regularly and evenly tipped with pale buff that the outline of each one is clearly defined. Compared with her mate's brilliant costume, the female wears a dull and somber dress, but it has a distinction of its own and is wholly in keeping with the character of its wearer.

The female I have mentioned was perched on one of the higher branches of the Oropéndolas' tree. At

this distance her distinctive markings were not at first evident but in her pose there was a dignity of carriage that marked her as unusual. A glass revealed her colors more clearly, the graceful lines of the head and neck and the large, dove-like eyes. She seemed to have nothing in common with the active, noisy Oropéndolas below her and in a moment was gone. This was on February 15, 1926. Two days later I saw her again in the same tree. Six days before I had seen a male perch for a few seconds in a neighboring dead tree. This ended my record of the species for the season.

The following year I watched the Oropéndolas more closely and on February 7 the female Cotinga was again seen in their tree. From this date I saw her not infrequently. Always she perched at the very top of the tree and soon was off for parts unknown. So closely did she disguise the significance of her actions that it was not until March 24, and then quite by accident, that I discovered she was actually nesting in the tree. My record for that day reads:

"While swinging my glass from Group 1 to Group 2 of the Oropéndolas my eye fell on a female Cotinga well down in the tree, partly concealed by a limb and apparently seated. A change of position, both by myself and the bird, showed that she was brooding

young, which, as she arose and stood at one side, raised their heads and widely opened their mouths. I could see only two. They proved to be covered with white down suggesting that worn by a nestling Cock-of-the-Rock. The nest-site is about 90 feet above the ground, in the pocket formed by an

The Cotinga near Her Nest

epiphyte with fifteen lanceolate leaves from three or four to about twelve inches in length, which is attached to a horizontal limb about five inches in diameter. The nest itself apparently contains but little material. The young were fed on what seemed to be pieces of some fruit which, after being prepared by the parent, were inserted into their gaping mouths. Between 2 and 4 o'clock the mother was absent and the young were then exposed to the sun. The male was not seen."

Referring to the available literature to compare my observations with those recorded, I found that although the Cotingas have been known for 160 years, and that the five closely related species of the group range from Brazil to Mexico, their nest had not before been discovered. Here, indeed, was distinction for Barro Colorado. We had heavy showers during the night, and at 7 o'clock the next morning the female Cotinga was brooding closely. At 7.45 she left, returning five minutes later with a supply of black berries about the size of a wild cherry. These she apparently fed to her young in so unusual a manner that I find it difficult to believe the evidence of my own eyes and a 24-power binocular. I give my notes, however, as they were written while the bird was under observation, with a hope that some day they may be confirmed. They state that the female "fed her two young by squeezing a berry about the size of a wild cherry into their opened, upraised mouths. After inserting her bill and the berry into their bill and squeezing, she would withdraw her bill and turn the berry over, pressing it at the same time and then squeeze it again into the mouth of the chick. Or she varied the process by swallowing the berry and regurgitating a fresh one. This lasted for about ten minutes, when she settled herself to brood. At the alarm-note of *Zarhynchus*

(the Oropéndola) she was up and alert; then resumed her brooding."

In all subsequent feedings the berries were given to the young without squeezing. Whether I chanced to see the last occasion on which they were fed this way or whether my eyes deceived me I do not venture to say.[1] I pass to my notes of March 27 and, in view of the interest attached to this species and our ignorance concerning its habits, give them in full:

"At 7.30 A.M. Cotinga was off the nest. At 7.40 she perched in the tree-tops, and at 7.45 flew to the limb at the side of the nest. Here, alert and nervous, she craned and bobbed her head, looking this side and that, her suspicions being probably aroused by the noise produced by a workman who was building a scaffold at the base of the tree preparatory to cementing certain fire-scars. Finally she was quiet, and for the greater part of the time until 7.56 perched by the side of the nest as motionless as a stuffed bird. Meanwhile the young, squatting low, gave no sign of life. At 7.56 the female suddenly stepped one step to the side of the nest, put one regurgitated berry then a second into the mouth of her young. She was now alert again while the young squatted as before. At 8.05 she went to the tree-top and at 8.08 left it in

[1] A record by William Gross in *Bird-Lore* for June, 1929 (p. 181), describing an essentially similar feeding method of the Cedar Waxwing, helps to restore my confidence in the correctness of this observation.

a strong, slightly undulating flight with wing-beats at the top of the curve. At 8.09 she returned to the tree-top with food in her bill and a minute later flew to the nest and fed apparently only one young; then swallowed the excreta. Always she was alert and watchful. At 8.30 she was off again, returning in five minutes to the tree-top, then within a minute going to the nest and feeding the young on regurgitated black berries. At 8.40 she brooded them. They look about two and a half inches long, have black bills and yellow-lined mouths. She continues to be exceedingly watchful."

March 28 the mother was seen feeding and brooding. I was now unavoidably absent for two days, and when I returned on the 31st I could see no signs of either mother or young. At 10.15 she appeared, perched in before unfrequented places both above and below the nest, and then left the tree.

On April first, I looked for the Cotinga but without success. On the morning of the 2d she came to the nest at 7.20, pulled something out of it, and flew off with it. Within two minutes she returned and picked rootlets from the nest, letting them drop. A small bird that chanced to pass was chased. She returned to the tree-top, gave chase to a Blue Tanager, then disappeared, all in the space of twenty minutes. At 8 o'clock she was back in the tree-top

and after five minutes went to the nest and looked into it and below it, and at intervals continued to pick it. At 8.20 she went from perch to perch through the tree. Obviously she was looking for her lost children. On this date I left the island.

In 1928 I looked for the return of the Cotinga even more eagerly than I did for the reappearance of the Oropéndolas, and when, on January 19, a female entered the sandbox tree she was welcomed with enthusiasm. I could not, of course, be sure that I was addressing the bird of the preceding season, but on February 8, when a female began to build on last year's site, I felt reasonably sure that she was "my" Cotinga.

She brought rootlets and long plant-fibers to the pocket formed by orchid and limb, and with the aid of body, feet, bill, and wings worked them into her nest. She was a thorough worker and assumed many poses in kneading her material to the desired shape. She invariably approached her home by way of the tree-top, waited there about a minute, then flew down to the nest where she "stopped, looked, and listened" at least another minute before she began work. The following day it rained in the morning and the Cotinga was not seen, but on February 10 building operations were resumed.

I did not learn the exact dates on which the nest

was finished and eggs laid, but on the morning of February 14 I saw a male Cotinga fly from the mangabé tree at the border of the forest to a group of trees where he was lost to view. A few minutes later a female Cotinga flew from these trees to the top of the sandbox and, after the usual pause, continued to her nest. There she settled herself, perhaps to lay.

Possibly the fact that it was St. Valentine's Day when, as the old legend has it, the birds are all choosing their mates, may not be without significance. In any event, my observations indicate that incubation was begun two days later.

Day after day the Cotinga now stuck faithfully to her task, leaving the nest only for brief periods for food or to attack any birds that aroused her enmity. On February 19, for example, she drove a female of her own species about the tree and, on March 11, she vigorously attacked a Paroquet that quite unwittingly came near her nest, flying over and darting down at it with an energy and fury surprising in a bird of such gentle appearance. The Paroquet, dismayed, attempted only to protect herself. A second, probably its mate, came, and they perched side by side, caressing each other, but even united they could not withstand the Cotinga who returned to the attack and put them both to flight.

On March 12 the Cotinga was still sitting. It was now at least twenty-five days since she began to sit and still there was no sign of a family. Could it be possible that in spite of the observation of February 14 her eggs, which should have been hatched in not more than eighteen days, were infertile and that she was not even a widow?

The following day the nest was deserted. Either the incubation fever had passed and the bird had abandoned her task or she had been killed. For the succeeding six days not a Cotinga was seen, but on the morning of the 20th a female perched for thirty minutes in the top of the sandbox but was not seen to visit the nest. How different this from the actions of the preceding year when, in response to the maternal instincts aroused by the coming of the young, the mother seemed half-crazed by their loss.

After the catastrophe of this year she had not only exhibited no further concern in the abandoned nest, but apparently could turn back the hand on the dial of her annual cycle from "incubation" to "nest-building." This statement is made in the belief that a female which, on March 24, began to construct a nest in the sandbox about forty feet away from the old site was "my" bird. On March 28, when my observations ended, she was still building.

To what may we attribute the disaster which on

two successive years befell this bird's home? The bright colors of the male certainly played no part in them for he was never seen near the nest. The colors of the female are inconspicuous and she herself used great care not to betray the location of her nest, always approaching it indirectly and with much caution.

Can it be possible that, as with the Oropéndolas, she lost her nesting-site when the forest was felled, or soon after, and that the sandbox was selected because it was near her former site rather than because it possessed advantages of its own? It was noticeable that while the sandbox was well-foliaged on January 1, as the dry season advanced it lost its leaves and in March was practically leafless on the windward side, which was where the Cotinga nested. Nests, therefore, which would be well-concealed in the early part of the season would later be exposed and conspicuous.

I cannot believe that the Cotingas' nest was looted by day, for the Oropéndolas would doubtless have given the alarm. If an Owl was the marauder, it may have been the same species that forced an entrance into the home of the Oropéndolas.

The Hummingbird

On January 16, 1926, a Black-throated Hummingbird was discovered building her nest in the sandbox

tree. She chose for a site the terminal portion of a long branch projecting to windward and with not a leaf nearer than twenty-five feet. It was, in fact, the most exposed situation in the tree.

It is a very large tree, not less than 130 feet in height and widely branched. There is, therefore, abundant room for many birds to build in it without interfering with one another. On the westerly side, where they were more protected from the strong trade winds of the dry season, the Oropéndolas were weaving their long, pendent bags on the outer branches. Nearer the heart of the tree a pair of Blue Tanagers and of Colombian Flycatchers had made their homes. All were on excellent terms with one another and were doubtless quite willing to receive the Hummingbird into the circle of their community life.

But the Hummingbird had ideas of her own. The aggressive, pioneer spirit which has spread her kind from Magellan Strait to Alaska has not developed a feeling of sociability in her tiny body. She not only asked for the control of her corner of the sandbox tree, but she demanded dominion over the entire tree, and what is more, she got it! Woe to the Oropéndola that ventured near her home. The fact that he was as large as a Crow did not protect him. Like a winged terror she darted fearlessly at him, and

evidently without thought of resistance, after dodging futilely once or twice, he would take to his wings. It was useless for him to retreat to his side of the tree. He was as helpless as a dirigible before a pursuit plane, and only the forest offered safety. Once on the warpath, the Hummer attacked any bird that she chanced to meet, and not infrequently she cleared the tree before her raid was ended. Then, like a bit of down, she returned to her nest.

Fortunately for the other occupants of the tree, as the season advanced the Hummer's domestic affairs claimed an increasing share of her attention, and they were correspondingly free from attaek. It was not possible for me to look into the nest a hundred or more feet from me, but it seemed apparent that by January 26 her eggs were laid, and she had begun to incubate. During this period nothing but her body stood between the eggs and destruction, one might say, by fire and water. Unshaded by leaf or branch, they might have been roasted if left exposed to the sun, and the nest-cup would have been filled to overflowing by heavy tropical showers if it had not been tightly capped by the little mother.

On February 9 it was evident that she had won her reward, for there were young in the nest. Within a week the tips of their bills could be seen above its felted rim. With a glass one could now watch the

remarkable process by which a Hummingbird, after plunging her stiletto-like bill into the throat of her young, almost to the hilt, pumps predigested food well down its digestive tract.

By February 20 the entire length of the young birds' still surprisingly short bills could be seen

Plunging Her Stiletto-like Bill down the Throat of Her Young

resting on the edge of the nest, and they turned their heads from side to side with an obvious awareness of their surroundings. Doubtless they left the nest within four or five days; but here, unfortunately, my observations for the season ended. Not once during the thirty-five days of my observation did I see the father of this family. True to the habits of his kind, he had apparently deserted his bride on their honeymoon. He had, I am sure, the sympathy of the

Oropéndolas, and at the best there seemed to be no room for him in the family circle.

In January, 1927, when I returned to Barro Colorado to continue my studies of the Oropéndolas, I saw with regret that the long, bare limb on which the Hummers nested had fallen. But from time to time I saw a female Black-throated Hummingbird pursuing the Oropéndolas, and I concluded that somewhere in the great tree she had a home. The tree was now fully foliaged, and to find a Hummingbird's nest within its innumerable branches seemed beyond the bounds of possibility. Nevertheless, with the aid of a 24-power binocular, mounted on a tripod, I determined to examine it systematically. The search began on January 19 and it ended the minute it began, for the first sweep of the glass revealed the bird seated on her nest. She had selected the nearest branch to the one that had fallen. Whether I was looking at my friend of the preceding year I shall never certainly know. But the fact remains that the same species was nesting in nearly the same place and at nearly the same time. Furthermore, the Oropéndolas will testify that she acted in nearly the same way!

My notes show that she was attending to her duties day after day, with an occasional foray into Oropéndolum by way of relaxation, until January 29,

when the record reads: "The Hummer's nest has disappcared. I cannot find the slightest trace of it or of the bird herself." I could not explain her disappearance, but whatever may have been its cause, it did not prevent her or one of her kin or kind from returning to the sandbox tree in 1928 and building a nest on (as nearly as I could tell) the site occupied in 1927. For the third successive year, therefore, a Black-throated Hummingbird nested in essentially the same place at practically the same time. It looked very much as though it were the samc bird! It was January 11 when I discovered the female building, and this year nothing prevented me from following the growth of her family until its members took to the air.

As stated in the preceding chapter, one of the most annoying cnemies of the Oropéndolas is the large Cowbird, Cassidix, that insists on depositing her eggs in their nests. She is wholly without shame and only the combined forces of the Oropéndolas prevent her from gaining access to their homes. It was in such an emergency that the Black-throated Hummer first showed a feeling of responsibility as a member of the sandbox tree community. Although both she and her nest were beneath the notice of Cassidix, she attacked the intruder with marked virulence, often driving her not only from the vicinity of her home but

continuing the pursuit until the would-be parasite was forced to leave the tree.

January 12, the Hummer added the last touches to her nest, and two or three days later, without loss of time, she concentrated her boundless energies on the

The nest was not only filled but overflowing with young Hummers

task of incubation. I have no record of the day her twins appeared, but on February 3 the tops of their heads were first seen above the edge of the nest. A week later their bodies filled the nest and they were so well-feathered that, after feeding them at sunset, their mother left them for the night.

By February 16 the nest was not only filled but overflowing with young Hummers. They were alert and observing, and passed much time in preening their plumage, as though they were oiling their

engines before taking flight. In further preparation for this great event, from time to time they stood up in the nest or even on its rim, stretched their now nearly grown wings, and whirred them rapidly in a mazy blur. This was admirable exercise, but they still lacked the impulse which soon would prompt them to "throw in the clutch." The power was there, but not the courage to use it. Early on the morning of the 20th the twins were still in the nest. The wind was high and they were tossed about as though in a stormy sea, but in the calm intervals they resumed the alar exercises that would make them master mariners in any weather. They looked as though they might "hop off" at the word "Go" and, when an hour later I returned from the forest, only one remained. While I was debating whether the missing bird had been blown off the nest during his[1] exercises, behold, he appeared, made a perfectly controlled landing, and sat there looking as trim, jaunty, fit, and self-confident as though he had been flying for years! We can imagine what he may have said to his less venturesome sister as he showed her how easily he could fly from twig to twig or hovered daintily over her. The exhibition finished, he re-entered the nest and snuggled down beside her, evidently quite content with his achievements and

[1] The characteristics of this bird seem to warrant the use of the masculine pronoun.

with no immediate desire to repeat them. The mother now fed the stay-at-home as well as the pioneer, and both young continued putting their plumage in order. There were doubtless many feathers to be freed of the remains of their sheaths.

Shortly after 1 o'clock the young male determined to try his wings again. Springing into the air above the nest, he faced the strong wind and for a time was content to hold his own before it; alighting, he repeated the performance. Doubtless his first flight was made in this way. Meanwhile the female stood on the edge of the nest and earnestly fluttered her wings for half a minute at a time. But the power evolved was not thrown into the machine so nearly ready to use it, and she finally settled back in the nest where she was soon joined by her more advanced brother. The mother now fed them both at half-hour intervals, and possibly stimulated by this nourishment and refreshed by several hours' rest, the male determined to widen his experience. At 5 o'clock, therefore, he left the nest, crossed a hazardous open space to a limb eight feet away, and, as evidence of his growing individuality, decided to pass the night alone in the open. For a creature that had been pillowed in down all his life and had never passed a night alone, this was indeed a courageous move.

My journal of February 21, reads: "At daybreak

this morning, or as soon thereafter as it was possible to see, I found the venturesome little Hummer where I left him last night. For nearly an hour longer he remained there, then disappeared. Was he alone or under the guidance of his mother, or did his paternal parent now appear to give his offspring the benefit of his experience amid the dangers of a crowded tropical world? Meanwhile the young female lacks the initiative to leave the nest, and without the incentive of her twin's example her launching will doubtless be still further delayed."

Two hours after this was written the young adventurer came home. For a quarter of an hour he did his best to induce his sister to enter the world with him. First he used suasion, standing on the edge of the nest and "racing" his wings. This having no effect, he employed force, poking his sister's neck and body with his bill, pulling her wing and sparring with her. But his efforts being of no avail, he settled down in the nest and crowded her to the opposite side.

It might be imagined that the male's action was designed to make a place for himself in the nest, but no similar passage had been seen between the two young birds before, and during part of the time that he was so energetically prodding his sister, she was perched on the opposite wall of the nest, leaving its

center free for his occupancy had he desired to use it.

After an hour's rest and two good meals from his mother, the young male set out in search of further adventure, and his sister, after being crowded for days, stretched herself out to enjoy the whole nest. But in the evening she was called upon to share it again. At 5.30 her wandering brother returned, claimed his share of the now much-worn nest, and after they had been fed by the ever-attentive mother, they settled down for the night.

They had not arisen at sunrise the following morning, but an hour later the male left his bed for a nearby branch, where he could more easily make his toilet. This completed, with much nervous twitching of the tail, betraying the forces within, he arose and fluttered over his ultra-cautious sister. Then like a dart he was off to the forest, perfect master of the delicate mechanism which makes a Hummer's flight, with its abrupt turns, its sudden stops, its aërial dancing, a marvel of dashing but controlled movement.

Meanwhile the weak sister bided her time; when her brother perched at her side, she stood on the rim of the nest and made a brave effort at flight; but it was all a gesture, and when he had gone, and with him the inspiration, she sank comfortably back in the nest. But she could not deny the call to wings much

longer. When next she "raced her engines" something happened, and suddenly she found herself perched on a twig above the nest. It was not a very long flight, only about six inches, but it was a flight and it was both convincing and encouraging.

She stood on the rim of the nest and made a brave effort at flight

After a rest of fifteen minutes and a general survey of her new surroundings, she ventured ten inches farther to windward and perched again. It was a short flight, but it had the important elements of starting and stopping; both were made with the skill of a veteran and, evidently flushed by success, the little aviator sat there looking very sprightly and

quite self-satisfied with her achievement, even if she was three days behind her brother. With unaccustomed freedom she now gave her plumage a thorough overhauling from the foothold of a firm if widely swinging branch. But this important operation was abruptly interrupted.

With complete disregard of the law of trespass, a male Trogon alighted above the nest and began to sound its mournful note, wholly ignoring the heiress to this territory who, from her perch not three feet away, regarded the intruder with unconcealed surprise. Preening was suspended, and the tiny bird, with bill inquiringly pointed at the stranger, was all attention. She was meeting her first bird outside the members of her own family and at the same time learning that if you want your rights in this world you must get them for yourself. But what could a midget Hummer, with only sixteen inches of flying experience, do to expel a bird thirty times or more her size? Nothing; she could only sit and wonder with that sharp little bill pointed upward at the huge creature. But she was far from being without a champion. From the air a small dark object hurled itself at the Trogon and with equal speed swung back again. Vainly the large bird swayed and ducked; at the fifth attack he seemed to be fairly knocked from his perch. It was evidently a glancing blow, for the fury of the fiery

little creature carried her past the Trogon toward the baby Hummer who, swept from her perch, either by a direct hit or the brush of her mother's wings, disappeared below. In a moment the mother returned, perched on the edge of the nest, and, for the first time since the eggs were laid, found it empty. She remained for only two or three seconds and was off, perhaps to search for the victim of her own maternal aggressiveness.

It seemed impossible, however, that the delicate little creature could have survived. Even if she had not been struck by her impetuous mother, she was far from prepared to save herself from the innumerable dangers of the world into which she had so suddenly been forced.

But I evidently underrated both the physical and mental powers of young Hummers. That evening both brother and sister returned. One, probably brother, sought a perch some thirty feet from the nest, the other came to within three feet of her birthplace. The faithful, and doubtless greatly relieved mother flew from one to the other, feeding each in turn and copiously.

At sunrise the next morning they had gone, nor did I see them again. But the end was not yet. On March 12, that is, just sixteen days later, the mother returned to the nest and started a second family!

Meanwhile, unobserved, she had renovated the old home and added new material to its walls. What an exhibition of exhaustless, irrepressible vitality!

On March 24 she was still sitting. Here my observations for the season came to an end, but if, as I believe, twins appeared within a day or two, it is obvious that their mother was not so completely separated from her mate as his apparent absence during the preceding sixty-seven days would lead one to believe!

CHAPTER VI

DOES THE TURKEY BUZZARD FOLLOW HIS NOSE?

WHAT are they hunting for, these endlessly wheeling, circling creatures? They get no crumbs from our table; the island has no beach on which the waves might spread them a feast. Occasionally a Coati dies in the clearing or an Iguana near the shore, and in due time they are devoured. These clearing casualties, however, must play but a small part in their regular food-supply. In the main they must depend upon the fallen animals of the forest—mammals, birds, snakes, lizards, perhaps even spiders, centipedes, and large insects. These sources of food may provide a feast or their failure produce a famine. It is doubtless the minimum amount of food that determines the number of Buzzards the island can support. What is our Buzzard population?

At about 4 o'clock on the afternoon of March 1, 1929, an apparent migration of Turkey Buzzards passed over the westerly end of Barro Colorado. They came from as far as one could see toward the north and maintained a general southerly direction

of flight at an average elevation of 500 feet. They were in loose flocks of twenty-five to fifty, separated by short intervals, and occupied about half an hour in passing. As a rule, they sailed straight but at times circled, though still drifting southward. Following the same line of flight, and sometimes mixed with the Buzzards, was a large blackish Hawk with long wings and tail, that I was unable to identify. Our local Buzzards were not affected by this, to me, unusual migration of their species and continued their customary wheeling over and near the clearing.

Except on this occasion I have never seen more than seven Turkey Buzzards at one time on Barro Colorado. They had assembled in the clearing to feed on the body of a Coati. As a rule, one does not see more than four or five Buzzards in the air at once, either from the laboratory or from the much wider viewpoint of the tower on the summit of the island. It is my belief, therefore, that not more than a dozen Turkey Buzzards inhabit Barro Colorado. If this be true, it is one of the rarest birds of the island, though its frequent coming and going, like the passing and repassing of stage troops, gives the impression that it is present in numbers.

These Buzzards of the forest are as different from those of the town and slaughter-house as a wild Mallard is from a puddle Duck. They are not sur-

feited with offal to be had for the taking. They are not so accustomed to man that one must almost kick them from his path to avoid stepping on them. They are hunters. It is true that they must be called "dead-game sports." It is also true that in the forest it is more difficult to detect game dead than alive. A Hawk's prey moves, calls, roams over more or less territory. He has only to wait in its haunts and sooner or later it will come to him. A Buzzard's prey is as motionless and silent as the grave in which it lies. To live, a forest Buzzard must be keen of sight and of *scent*. To deny him the sense of smell is to attribute to his eyes a miraculous power to see. Buzzards do not hunt through the forest; they course over it. Their food lies on the forest floor, often in deep shadow. They do not, in my experience, descend to this level until their meal has been detected. Only once in my four seasons on Barro Colorado have I found the body of a dead animal in the forest. This was a black Howling Monkey, but the Buzzards had found it first; as a matter of fact they led me to it.

Now if there be anything in protective coloration this dead Monkey was an exaggerated illustration of it. She was as dark as the forest earth without being a solid monotone, the outline of her form was broken, and she was unquestionably motionless. Nevertheless she was discovered beneath high forest with

lower growth so dense that in the absence of the Buzzards I had difficulty in returning to her.

Again, consider the flashlight of a Buzzard made by my colleague, Mr. Jaques. Here the bird discovered a small piece of meat with which a camera-trap set in the forest was baited. In both these instances, however, one cannot be certain they did not find their food by the use of their eyes. It is this uncertainty which, from the day of Audubon to the present, has made the Buzzard's possession of a sense of smell an open question.

It was on December 16, 1826, shortly after his arrival in Edinburgh, that Audubon appeared before the Wernerian Society and through its secretary presented a paper entitled "Account of the Habits of the Turkey Buzzard (*Vultur aura*) particularly with a view of Exploding the Opinion generally entertained of its extraordinary power of Smelling." The occasion introduced Audubon as an ornithologist to a European audience and was, therefore, of vital importance to him and to his work. In the second volume of his Ornithological Biography, published in 1834, he calls it his "maiden speech" and adds, "Well do I remember the uneasy feeling which I experienced." But his audience was sympathetic, he "was congratulated by the President, as well as by every member present," and Professor Jameson

requested permission to publish his paper in the Edinburgh *New Philosophical Journal*, where it filled twelve pages of the second volume (1826–27). It was also published in full in the *Ornithological Biographies* (Vol. II, pp. 33–43) and it is necessary, therefore, to quote here only the paragraph with which Audubon concludes the description of his experiments and observations. "I could enumerate many more instances," he writes, "indicating that the power of smelling in these birds has been grossly exaggerated, and that, if they can smell objects at any distance, they can see the same objects much farther." Then, with apparent pertinence, he adds, "I would ask any observer of the habits of birds, why if Vultures could smell at a great distance their prey, they should spend the greater portion of their lives hunting for it. . . ."

Returning to America, "urged by enthusiasm, to pursue the study of nature," Audubon found his observations doubted and he resolved to have his experiments repeated. For this purpose he enlisted the services of his new-made friend, the Rev. John Bachman, of Charleston, South Carolina. This fine naturalist's experiments wholly confirmed those of Audubon and they are certified to by six of his colleagues, including the President of the College of South Carolina, in the following statement:

"We the subscribers having witnessed the experiments made on the habits of the Vultures of Carolina (*Cathartes aura* and *Cathartes jota*), commonly called Turkey Buzzard and Carrion Crow, feel assured that they devour fresh as well as putrid food of any kind, and that they are guided to their food altogether through their sense of sight, and not that of smell."

It is approximately one hundred years since Audubon and Bachman made their experiments. From time to time casual observers have challenged their views which nevertheless have been generally accepted. Pycraft (*A History of Birds*, London, 1910) writes: "It has been satisfactorily demonstrated that their sense of smell is nil. They find their prey by sight." Forbush (*Birds of Massachusetts*, 1927) more nearly reflects current opinion in saying: "It is supposed that Buzzards find their food entirely by sight. . . ." But he qualifies this statement by adding, "There is some evidence to the effect that in some cases these birds have found their carrion by scent."

Here, then, is a subject to which one may, perhaps, contribute profitably, and I present, therefore, the results of tests made during the past three winters.

Some of my results leave no room for doubt that the Turkey Buzzard has a highly developed sense of

smell. From others, exactly the opposite conclusion may be drawn. I, therefore, give the evidence at length before offering further comments on it.

On February 5, 1927, when, as related beyond, Battle-axe, the Coati, died, I felt that his body should be offered to science under conditions where the Buzzards could find it only through their sense of smell. On the northerly or lake slope of Laboratory Hill, about twenty feet above the water, was the small building known as Shannon's Shack, to which I have already referred. It was well adapted for my purpose; there were no windows and but one door. In this structure, on the morning of February 6, I placed the body of Battle-axe, tying it horizontally close to the roof, which was thoroughly covered with tar roofing-paper. I then closed the door, except for two inches prohibited by its warping, but through which the Coati could not be seen unless one put his eye to the crack and looked upward. This little building was not in sight of the laboratory and, occupied with work and expecting no immediate response from the Buzzards, it was not until 12.45 that I went to look at it. I transcribe what follows from my journal. Most of it was written while the birds were under observation:

"At 12.45 I went to see if there were any signs of Buzzards near Battle-axe's house. There were two

perched on the roof of the house and while we watched them they were joined by a third, and a fourth sat on a stake nearby. They are the first Buzzards I have ever seen alight on the house. After a few minutes they left.

"About 1.35 a Buzzard appeared from leeward, crossing and recrossing an area at first about seventy yards wide but diminishing in width as the bird neared the house with the Coati. Reaching this point, the coursing to and fro, at the base of a V where stood the Coati house, became a circle, or rather descending spiral, as the bird was practically over the house. Several times a change in its course carried it to windward of the house but it at once swung back to leeward. At the end of about five minutes, the bird coursed leisurely to windward. Apparently it was looking for something from the moment it entered the wedge of scent presumably spreading from the Coati but, being unable to find it, went on.

"At 2.08 the breeze was fresh and the flag over the laboratory stood straight out. A Buzzard at a height of 60 to 70 feet sailed up the wind and right over the Coati house. At 2.48 there was very little breeze. A Buzzard appeared overhead at a height of 75 to 100 feet and after a turn or two at once circled down to the house. It sat on the roof quietly for a moment, then walked about and looked here and there over

A Buzzard on the Shannon Shack

With the other Buzzards, it was attracted to this building by the scent from the body of a Coati concealed within

A Turkey Buzzard Finds the Bait

(Flashlight by F. L. Jaques)

The American Museum's Habitat Group of Barro Colorado

A view from the Snyder-Molino Trail. The steamer emerging from the trees at the left is in the Canal
(Photographed by Edison Lamp Works)

the edge. It then flew to the ground 30 feet east, sat there for some moments, and returned to the roof of the house, spreading its wings and resting for a few minutes. Then it flew to the boardwalk on the westerly side of the house and about four feet from it, hopped along the walk toward the building, then to a pile of shingles and the partly open door. It looked as though the bird were about to enter the door when, startled by the drop of my focal-plane shutter, it took flight. Twenty-seven minutes had elapsed since it first alighted on the roof.

"4.15; no wind; flag limp. A Buzzard appeared about 200 feet above the house and at once circled down and perched on a stake 75 feet southeast of it. Two more arrived, went through practically the same movements, circling down direct. One alighted at the edge of the forest 80 feet away, the other on the house. After a few minutes Nos. 2 and 3 cruised slowly upwind and No. 1 alighted on the house, stayed a few minutes and, after circling overhead several times, coursed off to windward fifteen minutes after coming.

"4.35; breeze very light; Buzzard appears about 150 feet over Coati house, circles and beats always to leeward.

"5 P.M. Observations discontinued."

"Donato tells me that at 10.30 A.M., when return-

ing from Frijoles, he saw a Buzzard on the roof of the Shannon Shack picking at the roofing."

On the following morning, to continue from my journal, "the body of the Coati was removed from the house and placed on the grass outside under several thicknesses of mosquito-netting slightly raised from the ground. Later it was returned to the house. Several Buzzards seemed slightly interested but none gave such unmistakable evidence of awareness of its presence as was shown yesterday and none perched on the house. Two Black Vultures, however, perched in a tree about 125 feet to leeward of the Coati house. They are the first I have seen alight on the island."

Here, then, were two wholly contradictory results. From 12.45 until 5 P.M. on February 7, only one Buzzard came within 500 feet of the building in which the Coati was hidden without being obviously attracted to it. On February 8, although the odor of the Coati was more apparent, the place in which it was concealed was ignored.

No one seeing the actions of the Buzzards on the first day could doubt that they were attracted to the Shannon Shack. On the following day it was equally evident that they were not interested in this structure. Before attempting to explain their widely varying actions I will present additional evidence.

I now determined to change the character of the

scent with the object of making a fresh appeal to the Buzzards' assumed sense of smell. For this purpose Mr. Zetek sent me from the Panama market ten pounds of small fish. In order that their odor might be released at a known moment they were placed in a large tin box with a clamped, air-tight cover ("Cambridge can") and the box was put in the Shannon Shack.

On the afternoon of March 5, 1927, after waiting in vain for a high wind to fall, the cover of the box was removed. My colleagues, watching from the laboratory on the hill above and 150 feet to leeward, reported that so far as the sudden tainting of the atmosphere was concerned the experiment was an undeniable success. It failed, however, to attract the attention of the Buzzards. Two passed over at a height of several hundred feet, two were much lower, but not one hesitated in his flight.

In the belief that possibly the wind was too strong to permit the odor to rise, the cover of the fish-box was replaced. The following day the experiment was repeated under essentially similar conditions and with the same absence of positive results.

Only four days previously I had secured from Panama several far from fresh fish with which to drag the trails leading to the trip-wires of my camera-traps. Wrapped in paper they were left on a table

beneath my house. I found two Buzzards perched on a log lying on the ground about sixty feet to leeward of the fish, a place in which I had never seen them before. Part of these fish I afterward threw into a covered receptacle on the trail. The following morning two Buzzards were seen perched in a nearby tree. Here also the results are contradictory.[1]

The following year I continued the experiment, using the body of an old Coati which died on the morning of February 28. At 8 o'clock the next morning this animal was carefully concealed on the northerly slope of Laboratory Hill opposite a small building which had replaced the Shannon Shack, beneath a heavy covering of dead grass. The spot had been prepared for this purpose ten days before

[1] In this connection the following observations made at the laboratory by Dr. W. H. Weston, Jr., are of especial interest:

On March 22, 1929, Mr. Zetek brought to the island three large fish (Corbinas) which he had purchased in the Panama market that morning. At noon their entrails, wrapped in heavy brown paper, were thrown by a native, who cleaned them, behind the roots of the fallen sandbox tree. The package fell in a tangle of roots and weedy growth where it could not be readily seen. The following morning, from his table in the laboratory, Dr. Weston, saw two Turkey Buzzards in and near the upturned roots of the tree and perched on the highest root was a King Vulture, a bird rarely seen on the islands. With characteristic shyness the Vulture flew when Dr. Weston appeared at the corner of the laboratory building, but one of the Buzzards went behind the roots where it was surprised feeding on the contents of the paper package. While it cannot be asserted that none of the contents of the package appeared when it reached the ground, the fact that so small a lure in so inconspicuous a place should attract so rare a bird as the King Vulture is in itself worthy of record.

However, the observation does not end here. With the recurrence of Corbinas a week later, Dr. Weston completely enclosed their entrails in brown wrapping paper and tucked the package in the upturned roots of the sandbox where, closely matching its surroundings in color, it could not be easily distinguished. The Buzzards were again attracted and on this occasion one tore off the paper to secure the origin of the odor that had evidently enticed it.

by cutting the long grass, letting it dry as it fell and spreading over it more dead grass of a similar character. It was possible, therefore, to hide the Coati's body in any part of an area about thirty feet square without perceptibly changing the appearance of the surroundings.

When the body was hidden no odor from it was evident, and throughout the day it did not appear to arouse the interest of the Buzzards. At 8 o'clock on the morning of March 1, or nearly forty-eight hours after the Coati's death, evidences of decay were apparent when standing six feet to leeward of its thoroughly concealed body. The laboratory flag was barely stirred by the light northerly wind. While awaiting the appearance of Buzzards I returned to my house to resume observations on the Oropéndolas. About twenty minutes later two Buzzards were seen circling over the spot where the Coati's body was hidden. This was not visible from my post, and in the minute or two which elapsed before I reached the place the Buzzards had descended; one was found pulling the grass off the Coati carcass while the second one stood nearby. They flew as I approached.

A fellow-worker at the laboratory, who had a wider view, stated that he had seen these two Buzzards beating to and fro up the wind toward the Coati, narrowing their field as they drew nearer, and

soon sweeping down to alight on the ground to the leeward of the body.

In order to supplement observations on the Buzzards in the air with others made at close range, and to secure a photographic record, I now entered the Shannon House armed with an Akeley motion-picture and Graflex cameras and, except for an hour at midday, remained there until half-past four. The following notes were made as the incidents recorded occurred:

"8.25. Coati's body moved to position No. 2, about six feet northwest of the original position and thirty feet from my observation post and carefully covered. Wind northeasterly; light.

"8.45. Three Buzzards come from leeward; wind still very light; they course about always to leeward both high and low.

"8.50. A fourth Buzzard appears and two perch in the dead tree northwest of laboratory, distant about 250 feet.

"8.55. One Buzzard sails up and through the bananas and alights twenty feet north of Coati; stays for about three minutes and flies off. A Black Vulture sails over.

"9.05. Not a Buzzard or Vulture to be seen.

"9.13. One Buzzard high in the distance and to leeward, comes no nearer.

"9.20. A Buzzard sails over from leeward to windward.

"9.45. Observations discontinued for several minutes and when resumed a Buzzard was on the carcass tearing it and a second stood nearby. I drove the birds away and moved the carcass ten feet to windward covering it completely. (Position No. 3.)

"10.18. A Buzzard with bright red head alighted on Position No. 2, evidently looking for the carcass just removed. A second Buzzard came; they fought and flew away.

"10.20. One Buzzard returned and perched on a stake twenty-five feet to leeward of Position No. 1. Remained there for some seconds, then hopped to the ground and walked slowly toward Position No. 2. Stopped there, then continued up wind toward Position No. 3 (in which the carcass was hidden) going two feet to windward of it; but it at once turned and walked toward the carcass until it stood on the hay that concealed it. The Buzzard now picked, pulled, and burrowed in the hay until it began to tear the carcass. A second Buzzard came but stayed in the background. I went out, frightened the Buzzards away, and moved the carcass twenty-five feet to leeward, covering it thoroughly as before. (Position No. 4.)

"10.40. Two Buzzards, one with a red head,

alighted on Position No. 3, found nothing and flew off.

"10.48. A Buzzard with inner secondary missing from right wing wheels low in and out among the bananas with Coati's body as an approximate center; acts like a bird that is locating the carcass for the first time and by scent; at 10.55 it was still looking.

"11.08. A Buzzard alights near Position No. 3, walks to No. 2 and continues up the hill to leeward toward but to right of present position (No. 4), stands there for a minute almost to leeward of carcass then flies.

"11.25. Two birds alight thirty feet to leeward of carcass and sit motionless. In one minute one flies off; in another minute the other bird (with red head) walks with short stop toward the carcass and on to the hay over it, picks and pulls at hay for a minute then flies off. Wind somewhat stronger.

"12.10. A red-headed Buzzard perched fifty feet to windward; is frightened by man passing.

"12.12. After swinging low through the bananas a dull-headed Buzzard alighted fifty feet to leeward, walked a few feet toward the carcass, stood for about two minutes, then flew off. It is notable that no birds have alighted recently in old positions (Nos. 1–3) but all come to leeward of present position where they evidently have some difficulty in locating the exact

source of the smell that attracted them, only one bird having found it since the carcass was moved to Position No. 4.

"1.15. Return after an hour's absence and find body undisturbed.

"2.00. No Buzzards seen anywhere. This is the resting-time; not a bird voice heard. Bright sunlight all the morning.

"3.20. A Buzzard alights to north of body; stays half a minute and flies.

"3.40. Two Buzzards alight thirty feet to leeward of carcass; they fight; one walks to carcass, mounts hay, and pulls it off, exposing carcass which it proceeds to eat. I frighten it away and move carcass twenty feet to windward, covering it thoroughly. Position No. 5.

"3.50. Four Buzzards swecping low with Coati as center of their circling.

"4.30. Observations from house discontinued.

"5.30. Top of every limb of the dead trce near laboratory capped by a Buzzard—fivc in all. There is evidently something in the air. At 6.45 the following morning three Buzzards were at the carcass, which has been uncovered and dragged several feet from its hiding-place. I moved it twenty-five feet to leeward and re-covered it. (Position No. 6.)"

Returning from breakfast thirty minutes later I

found seven Buzzards on and about the carcass, which again had been uncovered and pulled several feet from its hiding-place. The birds now had the spot so well localized that when disturbed they merely flew to a nearby tree and it was believed that nothing could be gained by continuing this experiment.

The preceding data show wide variation in the behavior of Buzzards. Some birds ignored the Coati's body, some apparently detected the odor from it while on the wing and alighted but made no further effort to find it. Others were evidently aware of the scent while in the air, traced it to its approximate source, alighted to leeward of it, walked with little or no hesitation to the spot in which the carcass was hidden and removed the grass under which it was buried. No one could have asked for more definite and satisfactory proof that they were guided primarily by their sense of smell.

In 1929 this experiment was repeated with some variation but with essentially the same results. At dusk, on March 16, a Coati's body was placed beneath a pile of ties raised four inches from the ground, where it could not be seen from above. The opening was then closed with dried grass so that the Coati was equally invisible from below. It attracted no attention the following day, but on March 18 numbers of Buzzards obviously were aware of the odor

from it. On one occasion six were circling overhead at the same time. Several alighted nearby, but it was not until 6.15 P.M. that a Buzzard located the body and pulled the grass away from in front of it. As I approached it took wing.

The positive results obtained by these tests call for little comment. No one who saw the Buzzards coursing to and fro in increasingly short turns, alighting and going on foot direct to the invisible object, the odor from which had attracted them, could doubt that they were led only by their nose. It is the negative results that call for explanation.

Why, for example, in the experiments of 1927, did the Buzzards ignore the body of the Coati on February 8 when it had so obviously attracted them on the preceding day? Why did they pay no attention to the powerful odor given off by the fish in the tin box and still perch near those beneath my house and in the woods, and tear the paper from the entrails? It is failures of this kind on the part of the Buzzard to notice odors only too evident to us, that have led us to believe his nose does not function.

We know, however, practically nothing about the Buzzard's taste in smells. The varying odors of decay doubtless bring him more or less definite information concerning their source. Some obviously attract him; others may not. Nor, in these simple tests, had

I any means of determining whether odors apparent to me were always borne to passing Buzzards on the unstable air-currents to which the birds were constantly obliged to adjust themselves.

Furthermore, I was dealing with a limited Buzzard population, seven individuals being the largest number present at one time. It is possible to believe that all of these visited Shannon Shack on February 6, and, being unable to find anything edible, refused to return to it on February 7. For it seems evident from these experiments that the Turkey Buzzard, under primitive conditions, is not a mere stupid gorger on carrion but a bird dependent for its existence on its powers of flight and *discriminating* use of its senses of sight and smell.

CHAPTER VII

THE FOREST TRAILS

KIRTING the wall of vegetation at the border of the clearing, we may look in vain for an entrance to the forest. In this maze of trunk and stem, of rope-like lianas, spiked limbs, hooked leaves, and bewildering undergrowth, civilized man is obviously out of his element. He trips and stumbles and is captured by thorn and vine. He becomes impatient, possibly vocal, widely advertising his presence. All his attention is devoted to the ways and means of progress; his one object is to "get through." In short, he is a thoroughly misplaced animal and in a mental condition that neither induces nor facilitates observation. Put a machete in his hand and he slashes viciously right and left as though slaughtering an enemy at each stroke. He may make his way but at what a loss!

On Barro Colorado we are not at war with nature. Here, if anywhere, peace prevails. We are the friends, not the foes of the forest. To the foresight that made Barro Colorado possible the forest owes its continued existence, and the continued existence of the forest

in turn makes the objects of the Institute possible. So our aim is to preserve the forest and still make its resources accessible. To this end we must have trails. A tropical forest without trails is like a house with locked doors—we may force an entrance but we shall not be welcome. Trails, however, even through primeval forests, imply the presence of man—perhaps for centuries. They may, indeed, be well-traveled highways near which every form of life worth killing for food has long been rare or exterminated.

But the trails on Barro Colorado have no devastating human associations. We have evidence, in fact, that they are used by the indigenes as well as by ourselves. There are nearly twenty miles of these pathways and not one tree of size was felled in their construction. They form Barro Colorado's greatest attraction. They are cross-sections through the life of the forest and afford unending possibilities for intimate views of beast or bird and the forest itself. One may follow them almost as noiselessly as he glides along the shore in a cayuca. Instead of being an enmeshed, perspiring, vituperative creature one now feels more a part of the fauna.

To a surveyor the course of our trails doubtless betrays a lack of guiding principle, but therein lies their charm. Instead of radiating from the center of the island like the spokes of a wheel, they ramble

here and there, following the eontours and avoiding the large trees, or perhaps leading to them. All but the conneeting trails end at the water at a spot determined after it was reaehed; why should we be more definite? The longer the trail the better does it serve our purpose. The more frequent its turns the greater its possibilities. Who knows what the next turn will reveal?

If you would really see and know a trail, enter it without plan or purpose. Let your motto be "Where I am is where I'm going." Then you will not be haunted by an objeetive and, consciously or subconseiously, urged toward it. We are not out for exereise but observation, and are as likely to make it at our doorstep as on the other side of the island. There is apt to run in our head the feeling that the greater the distanee the greater the deed. Here, at least, is one place in the world where speed is at a diseount. Therefore walk slowly and stop often. Stopping is the very essenee of walking. All the moods of the day seem more vivid on the trails. Sunlight is never so radiantly eheerful as when it is reflected from a mosaie of leaves and its golden shafts brighten dark plaees; nor is shadow more somber than when clouds draw a veil aeross the sun and obseure its brillianey as sorrow drowns joy.

Birds' voices never sound more mysterious, more

alluring, than when heard from the trails, nor is silence more impressive or storm more terrifying. The truth is that trails lead us to the Presence of the Forest, and we are alert, responsive, expectant, awed as by a great and powerful personality.

There are nineteen different trails on Barro Colorado but day after day I find myself following much the same route. The more familiar I become with a trail the stronger is its appeal. Added to the endless possibilities of the future there is always the history of the past. The more memorable of one's experiences are recalled and perhaps, in part, relived every time he passes the place where they occurred. I make friends with certain vistas, plants, and trees; they acquire an individuality and as season succeeds season we develop a history in common. I look forward to seeing them as one does to visiting a friend.

A few yards from the entrance of the trail that begins at my doorstep there grows a grim strangler fig (*Ficus* sp.) which, having long since killed its host, stands alone. It is a favorite resort of Howling Monkeys who eat its leaves and at times sleep in its branches. With telling realism Mr. Jaques has immortalized it in his background of the Barro Colorado bird group in the American Museum.

When in this tree's annual cycle the time arrives for what a bird-student thinks of as molting, it sheds

its leaves so suddenly that within the space of five days it becomes wholly bare. At the height of this period the air below the tree is so full of falling leaves that one might imagine a score of Monkeys were shaking its branches.

Buds of the new leaves are now visible and after ten to twelve days the tree is apparently refoliaged. In a space, therefore, of about two weeks this tree has experienced the developments of late fall, winter, and early spring. In 1926 this Ficus began to shed on January 25. Its next year began on December 24, a month and one day earlier. The following year (1927), when I returned to the island on December 22, the "molt" had been completed and the new leaves were fully grown. In 1929 the leaves began to fall on January 5. During four seasons there was, therefore, a difference of considerably over a month in the length of this tree's year. Compare this wide variation with the remarkable regularity in the nesting-times of the Oropéndolas and other birds of the sandbox tree and we discover how much more responsive to the influences of their habitat are trees than birds.

The ground beneath the Ficus has been cleared and holds in regular rows short sections of sixty-two telegraph poles sent here to test their resistance to the attack of termites. They stand silently, in files,

little monuments to those interrelations in nature which connect the quiet and seclusion of a tropical forest with the forces of telegraphy.

It was from the trail at the upper corner of this clearing that studies were made for the museum bird group I have before referred to. The place is thus doubly connected with the outside world. It is also associated with one of the most remarkable bird characters on Barro Colorado, the Red-throated Caracara, a good-sized Hawk, black with a white belly and bare red face and throat. There are usually three or four of these birds together and they announce their presence by harsh, raucous squawks such as might be uttered by an insane Macaw. They are fearless and quite as apt to fly toward you as away from you, perhaps taking a perch not more than thirty feet overhead and addressing themselves unmistakably to you. This bird should play a prominent part in native folk-lore. No medicine man could ask for a better ally. I found them on this part of the trail several times before I discovered one clinging to the trunk of a small tree tearing open a wasps' nest attached to the bark and eating its contents, doubtless pupæ and larvæ, or both.

A turn in the trail hides its entrance and the entrancing view of the lake, and one is now entirely enclosed by the forest. At the right a fully grown

almendro rises to at least 140 feet. The trees of this species apparently bear a full crop only every other year, and in February, 1928, the ground here was strewn with fallen fruit. It was difficult to find a perfect one; Coatis, Agoutis, and, less frequently, Collared Peccaries had gnawed all or part of the thin, hard covering from practically every nut.

I have described the agility of the Coatis in gathering almendro nuts from a young tree in the clearing, but this tree on the trail is six feet in diameter and evidently too large for them to climb. They were obliged, therefore, to gather their share of the crop from the ground, and during the month of fruitage one or more Coatis could usually be found here at any hour of the day. The Agoutis came chiefly in the evening; to see them one had to approach cautiously. The Peccaries were casual visitors and never stopped long.

Mingled with the fallen almendro nuts were the peculiar, round, flattened, spike-beset fruits of the monkeys' comb.[1] Standley aptly likens them to sea urchins in appearance. Many of them had been opened and the black seeds, set in a white and yellow leathery substance, partly eaten. This is the work of the large Amazona Parrots. The dropping of bits of fruit as they steadily munch betrays their presence

[1] *Apeiba aspera.*

overhead, but if the tree is in leaf it requires the closest inspection to discover one Parrot where there may be a dozen. Probably only their movements, as they climb quietly about, will reveal them. They seem to know when they are seen. If one passes below without stopping they show no fear, but if one stops and is discovered, the tree-top explodes with ear-splitting screams as the birds take wing and with gradually decreasing vehemence trail their alarm through the air.

One is more or less prepared for the Parrots' outburst, but the Crested Guan breaks into full and startling cry without warning. Possibly the surprise is mutual. Their usual note is a high, thin yelp which rises and falls with their degree of alarm. From a low *peep* the sound apparently draws rapidly nearer, swells to so loud a shriek that you might think the bird was perched on your shoulder with its bill in your ear! He seems so needlessly frightened that I resent the implication of his protest. He is too large to be such a cry-baby. But his fear may be far from groundless, for Guans are favored by Ocelots and even Pumas.

The grade now becomes abrupt and at the top of the rise we are nearly 200 feet above the laboratory. The vegetation becomes more diversified. There are some beautiful examples of the stilt palm and, in a

small clearing which has been made to reveal them, a group of strangler figs (*Ficus*) presents such an impressive illustration of their power that one cannot avoid investing them with a personality. One can almost imagine he sees the struggles of one as yet sound, vigorous tree in the grasp of its foe. Another, long since dead, in the graphic words of Maud Haviland, lies a "rotting corpse" in the strangle-hold of its murderer. What bird was it, I wonder, that carried the fig-seed to the upper branches of these doomed and dead trees whence dropped the slender, string-like roots that became these octopus-like arms?

A few yards beyond we reach the entrance to the Shannon Trail. Here I always stop to look down the vista to the left and, as a result of the pause and wider view, this point is the scene of many incidents. In the latter part of December, 1926, a Red-capped Manakin conducted his courtship in and about a small tree near the junction of these trails. If he were as large as a Peacock or even a Bird-of-Paradise this diminutive creature of silky black costume, bright red head, white eyes and yellow legs, would be among the most famous of bird-wooers, but he is only the size of one's thumb. However, the tiny figure, to which he owes his family name, is no bar to his ambition, and he need only be seen in action to win a place in Cupid's Temple of Fame. For his inches he has no

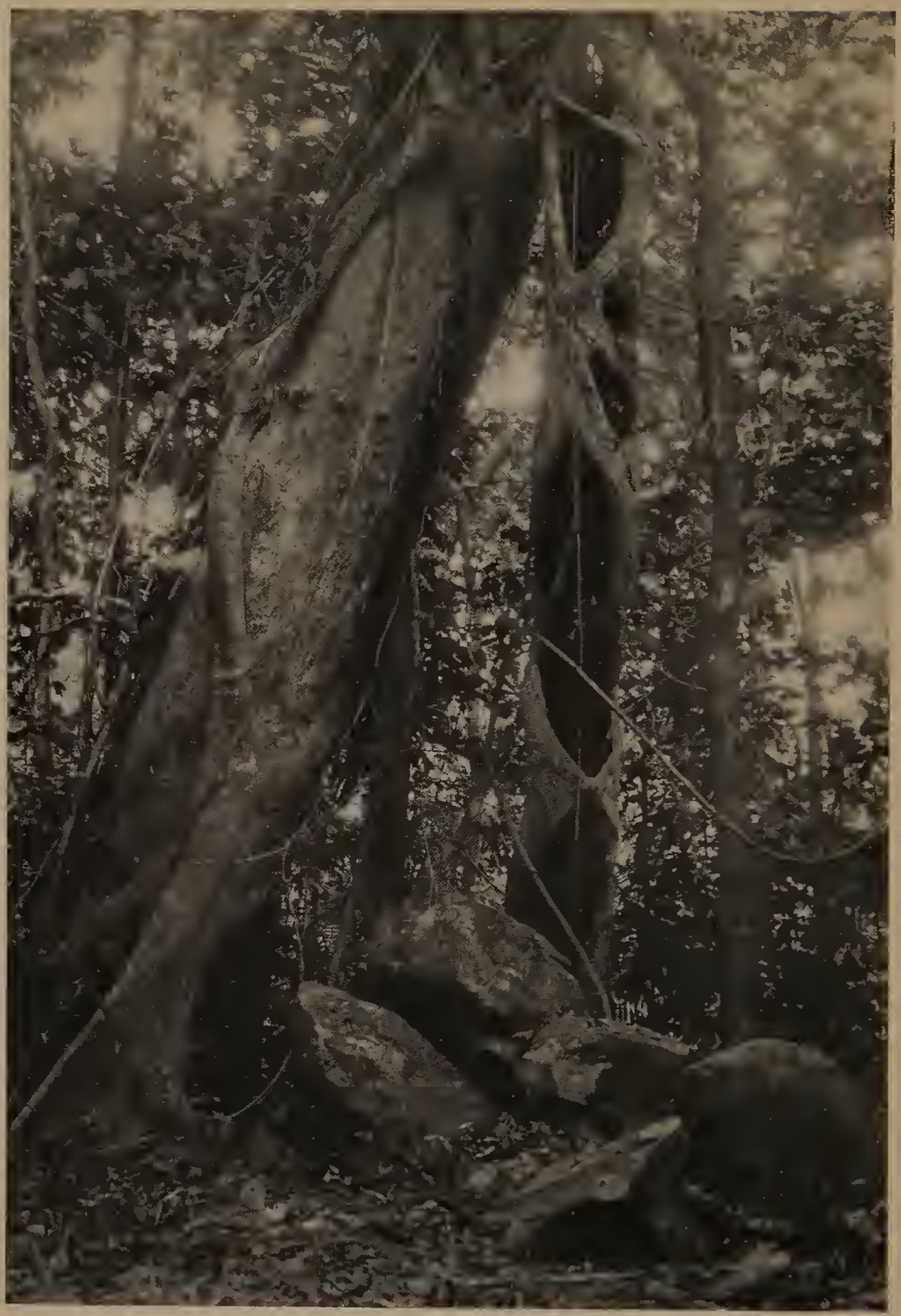
equal; it is, in fact, these same inches that permit him to pirouette and otherwise comport himself in a manner impossible for a larger bird. He has no plumes to display, no "tail" to spread and rattle, no special equipment other than a slight thickening of the shafts of the wing and tail-feathers and an extension of the yellow leg-feathers down the tarsi, and he gets his effects chiefly by his almost incredible activity. Let me try to give him his due by quoting from my journal:

The Courtship of a Red-capped Manakin

"December 25. A bright Christmas morning. As I reached the Shannon Trail where yesterday I met Lawrence's Wren, a Red-headed Manakin passed, buzzing, whirring, and snapping. He showed no fear and several times perched quite near me. He seemed much excited and his erratic dartings here and there proved to have a focal point of interest about fifteen feet from the ground on the thin, horizontal limb of a slender tree. Reaching this limb, he jumped from side to side for a distance of about fifteen inches as rapidly

The Forest from My Doorstep

The Frontispiece was photographed from the place on the trail where Donato stands



Strangler Figs and Their Victims

The larger tree is still living; the smaller one is a "rotting corpse" in the strangle-hold of its captor

as it was possible for him to move, varying this performance by sliding over this space with whirring wings; or, with his feet barely touching the perch, he made rapid sideways steps like a ballet dancer on tip-toe. After half-a-dozen jumps and a teetering slide or two, he would dart off, buzzing and snapping, going about fifty feet and then returning to the dance-perch. I now saw that the lure there was a little greenish bird who was perched quietly at the junction of the display limb with its trunk. She took no active part in the performance and after two displays changed her place, the male at once following her to repeat his exhibition."

At 8 o'clock on the morning of December 27, when next I visited this place, the tireless little lover was still ardently pressing his suit. He used the same limb, and the female occupied the same position as before. "Evidently," my notes read, "she is a willing observer of his wooing and takes a position where she may see and be seen. As before, the male jumped sideways back and forth, at the rate of about two jumps to the second; he also vibrated along the limb over the same space and as he approached the female his head was down, his tail elevated at an angle of about 45°, while the hind part of the body was raised to the limit of his leg-length, showing conspicuously the usually hidden yellow of his legs. To these

evolutions he now added a half-whirling pivot, facing first forward then backward, and punctuating each turn with a *whir-r-r*. He must have changed his footing with each change of position, but he moved with such rapidity it was impossible to see him do it."

The following day the courtship was continued with undiminished enthusiasm. Then the birds disappeared—let us hope to nest.

Gould's Manakin

Gould's Manakin, a slightly larger, more common species, with black cap, back, wings, and tail, an orange nape and throat, and olive belly, had, at this time, an assembling ground about 100 yards farther along the trail. In spite of the frequency with which I meet this bird I have never satisfactorily observed its display. It is usually found in low, bushy growths, in small companies of six to a dozen birds. The only vocal note I have heard is a slightly explosive *chee-ee-up*. To this is added a loud snapping, like the sound produced by the breaking of a dry twig, or the striking together of two pebbles, and a sudden buzzing *whir-r-r*, similar to but louder than the Red-head's, as

one would expect from its more narrowed primaries. The buzzing, ripping sound is made by the rapid vibration of the wings above the bird's back and can be produced while it is at rest, as well as in flight. I do not know how the snap is made; possibly by the bird's mandibles. At the height of the display, as I have seen it, a male springs from one perch to another a yard or so away, and immediately jumps back again, snapping with each jump, the whole creating a rhythmic *snap-snap; snap-snap*, with *whirrs* and *chee-ups* interposed. When several birds are engaged in this performance one can readily imagine them playing a game like "Puss-in-the-Corner."

Places on the trail where I have secured flashlight pictures of the animals that, unseen, tread them have their own special associations. At the large buttressed trees just beyond the Shannon Trail, and between the two Manakin stations, I "trapped" my first Puma, and as I pass this place his shade is always by my side. Spots where other animal pictures have been secured are similarly associated with the originals, each one of which has acquired a more or less distinct personality.

Or it may be merely an animal's track or some other evidence of its presence which we connect with certain places. An especially attractive bit of trail, near Wheeler, No. 5, has acquired distinction through a

single footprint. The absence of large trees exposes it to the sky, and in the wet season it receives its full share of rain. In the resulting soft mud I found, on Christmas Day, 1927, the imprint of a cat's foot as clearly impressed as though the animal had stepped in modeling wax. It measured six inches from heel to toe and four inches across the pad, both ways. After the rains ceased and the ground hardened and became covered with leaves, I kept a little place in the trail here raked clean and the surface soft and smooth with a hope that this animal might leave further evidence of his presence, but he did not return. I assume that it was a Puma.

The surrounding growth here is largely a slender, climbing bamboo. Among the large leaves of palms, heliconias, and aroids, so common along most of the trail, its foliage seems particularly delicate and lacy.

For some reason, doubtless connected with its food, the beautiful Cassin's Dove is almost invariably found here. Terrestrial as a Quail, it does not flush until one is within a few yards of it, and the sudden *whir-r-r* of its rounded wings sets the leaves flying and startles one pleasantly. This species was first collected in the Canal Zone in 1860 by James McLeannan, an employee of the Panama Railroad stationed at Lion Hill near Gatun. The spot is now submerged. It was described by George N. Law-

My First Puma

Flashlighted near Snyder-Molino Trail No. 4. It is believed that the same animal is shown in the following plate

A Not Fully Grown Puma

Flashlighted on Drayton Trail near No. 7. Note that the animal has stepped over the trip-wire to which a banana is tied with a white string. (*See page 206.*)

rence, of New York City, a famous ornithologist of that period, and named for his equally distinguished colleague, John Cassin of the Academy of Natural Sciences in Philadelphia. In 1887 the type of this species, with the rest of the Lawrence collection, was acquired by the American Museum, whither Mr. Lawrence's heart followed it. Often he came to the Museum to see his treasures or to add to them, and when I meet Cassin's Dove on the trail there is in the background of my mind a picture of a gentleman of the old school whose eyes, as he talked of birds, shone through his great spectacles with the sparkle of boyhood. Our birthdays were separated by nearly sixty years, but as bird-lovers we met on common ground. I am not likely to forget a specimen of a Hummingbird he brought to the Museum one day. He had just acquired it from John Galbraith who had collected birds in Panama with McLeannan. Mr. Lawrence had never seen a Hummingbird like it (nor, as it proved, had anyone else!), and with enthusiasm uncontrolled by experience I described it as a new species, discovering later that it was composed of the front half of one well-known species and the rear half of another, so cleverly put together that the joint was not evident!

To return from this little journey down the trail of the years, just beyond the bamboos, at a turn in the

trail where in the dry season the ground is usually strewn with the "powder-puff" blossoms of *Bombax*, is the iron body of a little car, relic of the disastrous days when France gallantly matched her resources against an unseen foe and lost. A little farther up the hill lies another car on which, in January, 1929, I found a brass tag reading: "G. Belia D Ingr. A Paris, M. 18 Rue Choron."

Various are the theories advanced to account for the presence of these several hundred pounds of iron nearly 500 feet above the valley in which they were used. That they were part of a "still" is one theory. But that merely adds one mystery to another. There was no need of a still here when the cars were dragged up from the Chagres Valley, but at this elevation water was as scarce then as it is now. Not far away the presence of coconut trees gives evidence of the former occupation of man, for whom these iron boxes may have served as water-tanks. But whatever their history, they carry one's thoughts backward to the time when the broad lake below was a forested valley, through which flowed a river whose very name was a symbol of disease, where hundreds of men toiled against overwhelming odds.

From this point to the summit the trail passes along the crest of the island. The forest appears to be second growth, though it is possible that rapid

drainage to one side or the other may in part account for the rather scrubby vegetation.

This is a good section for various species of Ant-birds and the renegade Ant-Tanager, which has apparently deserted the tree-tops, frequented by most members of his family, for the lower growth and, in consequence, acquired, in a measure, the dark colors of forest-floor birds. The change appears to have affected his disposition unfavorably, for few birds of any species, and certainly no other Tanager, scold the passerby so persistently or in so harsh a voice. If he has a redeeming song I have yet to discover it.[1]

Near here I first learned one of the calls of Lawrence's Antpitta who looks like a plump young Robin when he perches, but has long legs and can run like a shadow. Subsequently I discovered that this elusive bird has a surprising variety of whistled notes. Most of his relatives live on the ground in the forests of the higher

Lawrence's Antpitta

[1] On March 25, 1928, within three weeks after these words were written, at the very place on the Wheeler Trail here referred to, I heard the Ant-Tanager sing so charming and unusual a song that, in my estimation, he at once entered the first rank of bird vocalists. The song is described elsewhere. The moral is obvious.

mountain life-zones where they are rarely seen but frequently heard.

A second island Antbird, *Formicarius analis*, is common and would be equally difficult to see if he did not so promptly answer an imitation of his three or four plaintive minor notes. One has only to whistle in turn when, with hesitating steps, short tail erect, ruddy lower tail-coverts showing, head turning this way and that in quest of his challenger, the gallant little bird will walk almost to your feet. He looks like a diminutive Cock-of-the-Woods, and in Trinidad, indeed, is called "Coq Bois." Alarm him and he is off with the speed of a Rail.

"Coq Bois"

Sclater's Antbird, another deep olive and black species of the lower growth, will also come when called. He, in fact, says quite clearly and emphatically, *come here*, or *come-right-hére*. He is not terrestrial but haunts fallen tree-tops and similar dense tangles and approaches you from twig to twig, flitting his wings nervously, and gesturing with his

half-spread tail, until you can see his bare, blue face. When he is mated he usually brings his wife with him. She dutifully repeats his notes, but is always a little off his key, though apparently in perfect harmony with his sentiments.

Anywhere on the trail one may chance to hear the low *chir-r-ing* of the Bicolored Antbird. Follow it and you will doubtless find army ants moving rapidly on broad fronts and narrow fronts, great masses and single columns. Viewed separately, each group, or detachment, seems to be acting independently, but as a whole they are guided by a common purpose that carries them forward without confusion. Silently, relentlessly, the black hordes flow over the leaves. Roaches leap from cover and frantically try to escape, but are soon a mass of devouring ants. Centipedes are no more immune than moths. One expects to hear the blare of trumpets and cries of agony but there is only a rustling in the leaves and the voices of birds. *Gymnopithys* never ceases his whining *chir-r;* McLeannan's Antbird utters a prolonged musical twittering; and the little Spotted Antbird of the white throat and black necklace, who seems to regard the whole affair as a joke, utters a quaint, humorous ditty singularly out of keeping with the grim spirit of death and destruction by which he is surrounded.

These three birds always attend the army ants.

The first two I never see elsewhere. *Eucometis*, the Tanager, I rarely see except with the ants. There are also other Antbirds, a few Woodcreepers, and, at times, even a Motmot. The ants act as spaniels, flushing hidden game which the birds promptly capture. I have seen ants running over a bird's toes while it was watching for other prey, but I have never seen a bird eat an ant, though they may inadvertently swallow them when robbing them of their prey.

After crossing several small bridges over water-worn barrancas, a short, steep ascent brings us to the highest point on the island—537 feet above the sea, 452 feet above the lake. A small space was cleared here to make room for a surveyor's signal. This gave us an outlook but we soon found that unless the new growth was cut yearly it was impossible to see over it, and a tower 28 feet in height was therefore constructed. From its top, on a clear day, one can see from the wireless towers at Darien to the Caribbean. The panorama includes nearly one-half the canal area and by far the most beautiful part of it. To the northwest lies Gatun Bay, with its countless islands; northward, bordering the shores of Barro Colorado, are small lakes and lagoons with river-like stretches all bordered by forest and backed by mountains; to the east is Frijoles Bay, and in the foreground, every-

where, tree-tops of an infinite variety of greens broken by blossoms of many colors.

It is a notable view of mountain and forest and quiet waters where cayucas and other lake-craft seem at home, and it is not until an ocean liner emerges from the trees, almost fills one of the lagoons, and disappears in the growth on its opposite side that we realize we are looking at a transcontinental waterway.

To the bird-student the tower is a capital place to see what is going on in the air as well as in the tree-tops. From it I saw my first Sacred Vulture on Barro Colorado, floating over the forest below. Here one may watch for Swifts and diurnal migrants like Swallow-tailed Kites. The pink madroño blossoms,[1] near at hand, give one close-up views of Hummingbirds and Honeycreepers, and in a slightly more distant cecropia Toucans feed. The open branches of this tree were long the look-out of a Dyson's Puffbird. He sat here literally by the hour, squatting on his tarsi with his heels below the level of his toes, his flank feathers slightly expanded, looking as though he were molded to his perch. To the casual observer he was merely the "stupid Puffbird" of the ornithologies; but keep your eye on *Notharcus* for more than a passing moment and see just how "stupid" he is. He

[1] *Macrocnemum glabrescens.*

sits there quietly and honors you by not flying. He is conserving his energy. He does not change his perch but constantly alters his pose. His eyes are bright and never idle; his head is in constant motion. He peers and "cranes" and "hawks" with a forward-reaching, sinuous, raptorial motion. Evidently he is looking for something, keenly, intently. Suddenly he sees it and like an arrow shoots from his perch straight for a leaf distant perhaps seventy feet, strikes his prey, and returns with it to his perch. Ask the insect he is gulping down if *Notharcus* is stupid!

Continuing on the Wheeler Trail, we will find at its junction with Armour a place where from the latter half of January until late March the scarlet passion flower[1] is abundant. The scarcity of flowers near the forest floor makes these large, brilliant blossoms doubly conspicuous. Usually they grow from bare, climbing vines, but when the vine that bears them creeps along the earth, the flowers may appear among dead brown leaves in surprising contrast with their surroundings.

The comparative absence of flowers along the trails is in a measure compensated for by the colors of the new leaves, many of which grow from the stubs of trees cut in making the trails. Seen in

[1] *Passiflora vitifolia.*

Dyson's Puff-bird

He is perched on his lookout, in a cecropia near the tower

The Canal, Looking North from the Tower

An ocean liner is bound for the Pacific

The Mainland from Redwood House

(*See page 235.*)

masses, these colors give somewhat the effect of autumn foliage. Seen in detail, at one's feet, their unusual shades and perfection of form are a source of exquisite pleasure. There are no primary colors. Soft, blended tones of ochre prevail, and the range is from a delicate flesh-tint to a rich but subdued shade of purple. Nearly every leaf is absolutely flawless from the symmetry of its form to the minutest detail of its outline and venation. When new-born, as they hang limp in clusters, they suggest moths that have just emerged from their cocoons and are waiting for their wings to dry before taking flight.

Flowering trees, whose brightly colored crowns are only partly visible from below, also contribute to the beauty of the trail. When the guayacan[1] sheds its blossoms, the ground below seems sprinkled with gold. The jacaranda[2] tints the forest floor with royal purple; the shuttlecocks of the palo santo,[3] with red; the Panama tree,[4] with black and orange; and I have seen the trail and bordering wild pine-apples beneath a roble[5] as thickly covered with its large, shell-pink blossoms as though they had been heavily showered with confetti.

There are also brilliantly colored butterflies to take the place of flowers; red and black and yellow Heli-

[1] *Tabebuia guayacan.*
[2] *Jacaranda copaia.*
[3] *Triplaris americana.*
[4] *Sterculia apetala.*
[5] *Tabebuia pentaphylla.*

conias, and the great blue Morphos that always supply a supreme color sensation. They dance erratically along the more open trails, like leaves in a gale, but try to catch one and you will discover that it knows quite definitely where it wants to go. Aviators in the Zone tell me that Morpho, flashing its glittering wings, may be seen from a height of one to two thousand feet. The species should have been named *Morpho heliographica.*

Even before the ground begins to face toward the southern shore of the island, the character of the forest changes. The trees are larger, the lower growth less dense. The Manakins, Cassin's Doves, and Ant-Tanagers are replaced by bands of noisy Fruit Crows; one is challenged by the loud, astounding whistle of Lathria; from the tree-tops the "Je t'adore" of the Black-billed Pigeon assures his mate of his continued devotion; Guans cry out suddenly in great alarm and Toucans yelp and croak. I listen for the questioning call of White-faced Monkeys or the low grunt with which Howlers preface their roar. I "try the air" for a whiff of the Peccary's distinctive odor.

It was just at this point in January, 1926, that I encountered several of these birds and mammals at impressively close range. A large fig tree, laden with ripe fruit, was our meeting-ground. Standing beneath it I counted two Swainson's Toucans, five

Crested Guans, and six Howling Monkeys. All were gathering figs. The Toucans' bill and the Guans' neck gave them length of reach readily to pluck their food, while the Monkeys, heavier of body, could not venture so near the terminal fruit-bearing branches and therefore pulled them to within eating distance, at times breaking limbs up to half an inch in diameter. All went well until a Guan chanced to see me in the undergrowth below him. At once he sounded his loud complaining *ooo-eek*, *ooo-eek*. The other Guans joined in the outcry and the air rang with their alarm-notes. The Toucans now began to yelp, and an old male Howler determined to investigate the cause of this disturbance. Climbing slowly down a limb in my direction, he peered at me in an intent, personal way, grunting inquiringly. His grunts grew louder as he came nearer and at a distance of about forty feet culminated in a terrifying roar. I could see most of his teeth. His companions above added their voices, and the combined efforts of Guans, Toucans and Monkeys produced an inspiring if somewhat overpowering serenade. So entranced was I by this performance that I did not observe the arrival of more fig-gatherers until, from the corner of my eye, I saw something move in the trail and discovered two Collared Peccaries standing within twenty feet of me. They stared insolently for a few

seconds and then continued their meal of fallen figs. Behind them, in the undergrowth, were others; I could not tell how many. The situation was interesting, and although I knew that there was not the slightest danger I had a distinct impression of being menaced both from the air and the earth.

For ten minutes the Peccaries continued to feed, creating surprisingly little noise, then in single file they passed me, sixteen adults and two little ones about the size of an Agouti. With the object of securing an advantageous position for photography, I returned in the afternoon and built a small perch in a tree which commanded a clear view of the trail in both directions, but my vigils were fruitless.

The trail now passes through as fine forest as there is on the island. Whether or not it is primeval I do not know, nor is it material. It is mature, and its ranks are full. No forest can offer more. There are no rough or shaggy trunks. The bark is usually smooth, like that of our beech, but it is variously colored and mottled with shades of gray and brown. Some trees are ponderously columnar; others suggest stripped athletes, with muscles and sinews swelling beneath their thin skins.

When in the presence of such luxuriant, majestic growth one is overpowered by its profusion and variety, and in the effort to gain some definite im-

A Lookout on the Wheeler Trail

A Collared Peccary Passes beneath the Wire

A main highway on the Armour Trail. (*See page 198.*)

A Tayra on the Armour Trail

The only photograph secured of this marten-like animal. (*See page 198.*)

White-lipped Peccaries

Note the animal in the rear rubbing his head on his neighbor's flank

pression of its character, I focus my attention on the tree nearest me. I do not know its name and I have a feeling that the tree, not man, should give it to me. At a height of six feet it has a circumference of 22 feet, and it remains essentially this size until about 60 feet from the ground, when it branches. Heavy vine cables cling to its sides and encircle it; others, equally large, drop straight as a plumb-line from its branches. Its great limbs are almost concealed by masses of parasitic vegetation and deeply fringed by long, swaying ferns. It presents an amazing exhibition of the productiveness of the earth under the combined influences of air and water. If it stood alone it would command all the tribute one's nature could render it, but it is only one among many; others equally impressive surround it; one seems in the presence of a Stonehenge of trees. Beneath the taller trees grow shorter ones, and beneath these others still shorter, while below them all are the undergrowth and plants of the forest floor. No habitable place is vacant; every niche holds some form of vegetation.

In all this assemblage of forest patriarchs I figuratively bend the knee most deeply to the largest specimen of almendro I have ever seen. To be exact its station is Wheeler Trail No. 16; five feet from the ground its circumference is 19 feet, and it is not less than 150 feet in height. The two specimens of spiny

cedar[1] on the Allison Armour Trail have greater girth and wider spread of branches,[2] but they do not compare with the almendro in symmetry. They are like monstrosities—all body and arms and no head. But the almendro is beautifully proportioned. Its great limbs are worthy of its trunk, and its crown rises majestically above them. Its bark is clean and looks well-kept. With the exception of a large aroid where the limbs leave the trunk, it is without parasites. It is an individual, not a flora, and one has a feeling for it which trees whose identity is lost beneath a weight of clinging vegetation cannot arouse.

For over half a mile the trail continues through this forest, and always there are in sight trees just as worthy of description as the two I have mentioned. Each year, before leaving Barro Colorado, I come here for a last view of the forest, and not alone to see, but to hear it. How countless are its voices! The ripple of the wind coming from afar passing overhead and losing itself in the distance; the soft fluttering of leaves that, like prisms, set the light-waves dancing in a world of shimmering gold and green; the startling crash of a limb, or even tree, whose time has come; footsteps in the undergrowth; the swish of branches beneath the weight of some jumping animal;

[1] *Bombacopsis fendleri.*

[2] The first tree is 21 feet in circumference 30 feet up, and has a spread of 192 feet. The buttress of the second tree is 31 feet across the face and 90 feet in circumference.

the fluff of unseen wings; the patter of raindrops growing in volume as the shower approaches; the cries of Monkeys and, above all, the calls of birds. On March 28, 1928, it was a fitting climax to the season to see here a Puma creeping silently through the undergrowth. As I watched him he turned and vanished. A hundred yards farther along the trail I encountered a band of Peccaries he doubtless had been stalking.

CHAPTER VIII

WHO TREADS OUR TRAILS?[1]

WHO treads these trails? We often meet Coatis, Agoutis, and Collared Peccaries, all diurnal animals. But, exclusive of bats, Goldman's *Mammals of Panama* records over fifty species from the Canal Zone. Doubtless most of them inhabit Barro Colorado, but how can we establish the fact of their presence?

We might use dogs and the methods of the chase. We might set traps; we might even resort to poisoned bait. But the motto of Barro Colorado is "Live and let live." We want a census of the living, not a record of the dead. How then can we make it? The answer is by that type of flashlight autophotography of which George Shiras, 3d is the father, and William Nesbit the eldest son. Armed with two of the latter's outfits I have devoted the margin of time left by bird-studies to securing photographic records of the mammals of the island, particularly of those that walk or fly by night.

If there be any sport in which the joys of anticipation are more prolonged, the pleasures of realiza-

[1] Courtesy *National Geographic Magazine.*

tion more enduring than that of camera-trapping in the tropics, I have yet to find it! From the moment when, after considering all the possibilities, you select a place in which to set your "trap" until the developments of the darkroom show what you have, or have not captured, imagination keeps pace with expectation. The result is often complete and bitter disappointment. But it may bring such elation that, so narrow are the bounds between the manifestations of uncontrolled enthusiasm and dementia, it is safe to give full expression to your feelings only when you are alone!

To encourage the close approach of animals to the laboratory, the nearby ground has been declared *sanctum sanctorum* and flashlight photography is prohibited. Beyond a distance of 400 yards this restriction is removed, and one is free to employ any fair means to capture the image of his prey.

Now begins a still hunt for evidence that an animal has visited and may return to a given locality that calls for the hunter's skill in the discovery and reading of signs. This is fascinating work. It gives added interest to every forest outing. During the dry season the ground is hard and usually leaf-covered and tracks are difficult to find. But the appearance of the fallen leaves often gives some indication of the passage of larger animals.

As the dry season advances, one should follow the small water-courses and hunt for little water-holes. Water, however, is not the attraction on a small island that it is on arid plains. On Barro Colorado an animal in search of water may go to the shore. When the level of the lake has fallen, exposing small, sandy beaches at the mouth of inflowing creeks, one may find their record printed large.

Influenced by the belief, doubtless erroneous, that our trails look as attractive to animals as they do to us, when all signs fail I stretch the camera trip-wire across them. Furthermore, pictures of animals following in our footsteps possess greater interest than those that might be secured in parts of the forest which we rarely, if ever, visit. One now selects a place in the trail over which, for one reason or another, he thinks an animal will pass. For example, where fallen fruit offers food, or the lower growth is of wild pineapple and the trail affords an easy way through it; where trails cross, or where they cross streams or end at the water. One of my most productive stands had, apparently, nothing to recommend it but two trees; but the camera showed that there passed between them a Spiny Rat, a Bat, Tayra, Collared Peccary, Puma, Baird's Tapir, and a man! The place was near the summit of the island and probably on a natural highway.

The stand having been selected, the trap is set. This is a fascinating operation. One visualizes the possible subject and the direction from which it may come and decides upon the distance and the angle from which it should be photographed. The camera is then set, the battery and auxiliary flash attached to trees or stakes on each side and slightly in the rear. A fine wire is run from tree to tree across the pathway the subject is expected to travel and, after passing through a staple, is connected with a small chain leading to the battery. Unless this side-wire be sufficiently elevated or properly guarded it may be sprung by some animal crossing instead of following the trail.

Early in my experience with this kind of hunting, I had gone less than 200 feet from the camera after setting it when the charges exploded. The sound was like the report of a small cannon. Smoke was still drifting through the trees when I reached the stand but no sign of life was visible. The developed plate, however, showed the tip of the tail of a Coati which had crossed the trail directly in front of the camera.

Boxes, sealed with paraffin, and each containing half an ounce of magnesium powder are now placed in the metal cups of the battery and auxiliary flash. One of the cups heads a plunger connected with the shutter-release so that the force of the recoil occa-

sioned by the explosion exposes the plate at the moment of greatest illumination. A 6-inch lens is used wide open and the shutter is set for an exposure of a two-hundredth part of a second.

After the several wires are connected, the shutter arranged, and the slide drawn from the plate-holder, it remains only to close the switch that sets the trap. This operation is not without that element of danger which, aside from the fact that, unarmed, we are in the haunts of predatory animals so aggressive we rarely see them, places flashlight photography in the field of true sport! Electrical devices in the hands of the uninitiated sometimes do inexplicable things, and I never complete the wire connection without tense expectation of its attendant possibilities.

Since this is a chapter on autoportraiture it may not be out of place to introduce here a self-drawn sketch of myself: Costume negligible; in my right hand a child's rake; attached to the back of my belt is a long, white cord to the end of which is tied several pounds of meat. The rake serves as an alpenstock and as a tool with which, from time to time, I stop and rake the leaves from the trail, soften and smooth the ground thus cleared. The meat drags on behind and occasionally I turn to help it over some obstruction. It sounds idiotic, it looks idiotic, but there is method in my madness. The trail is cleared

at intervals and the ground prepared to make spaces where the footprints of passing animals may be recorded. The meat is dragged at the end of the string to lay a trail to and beneath the trip-wires of the camera-traps. Both activities, therefore, are reasonable as well as useful.

This question of luring animals to the trip-wire is an important one. Food tied to the wire may attract the larger animals but it is far more likely to bring the small rodents or Opossums. For the first three or four nights at a new stand, therefore, I employ no bait or, as described, merely drag it beneath the wire. If this fails, a ripe banana tied to the wire has been found to make a more universal appeal than any other food.

From what has been said it is clear that camera-trapping calls for the display of more or less imagination. The game is unseen; its very existence in the region may be questionable; signs must be identified and interpreted and the future course of their author predicted. Hence, in the mind of the camera-trapper there are formed many pictures of imaginary animals doing imaginary things with imaginary results. In this series of mental photographs none recurs more frequently than one of a Jaguar in the trail near, quite near, a trap into which I lead him by a judiciously executed retreat. With the resulting explo-

sion he takes to his heels, my safety is assured, and his picture is made!

Returning to matters of fact, after the details of setting the camera have been attended to one returns to his base. Possibly during the night he may hear the booming report of an explosion and visualize the eye of the camera quickly opening and closing to record on the "retina" of the sensitive plate the image of whatever fired the flash. Where the fauna is well-known one may usually surmise whether he has caught large game or small; but on Barro Colorado, during the first year of my trapping, there was no census of mammals and the possibilities included most of the terrestrial species of tropical America.

The return to the trap is made with high hopes, which it is well, however, to keep within control. Failures far outnumber successes in autophotography. The magnesium powder is packed in round red boxes the tops of which may be seen from some distance, in the shallow metal cups from which they are exploded. We are told that red is a cheerful color, but these neat little disks are a depressing sight when you find them as you left them. Far more cheerful are the scorched box-bottoms and burnt-out fuses bearing silent testimony that the trap has faithfully performed its part. Anticipations which were born when the stand was selected now acquire new strength.

What manner of beast sprung the trap? What potential image lies on the coated surface of the glass plate resting quietly in its holder? The surroundings are minutely examined for clues. At times a foot-print is visible, deepened, perhaps, by the spring of the startled animal which, in the stillness of the night and seclusion of its haunts, suddenly comes into close quarters with thunder and lightning. The extent to which the wire is stretched gives an indication of the strength of the animal that sprung it; the direction in which it is stretched tells from which side the creature came. If the wire is broken, imagination, given rein, runs wild among the larger possibilities.

With the reasonable certainty that you have almost within your grasp the picture of some long-desired species, there follows a trying period. Between failure and success are interposed the countless mishaps of photography; you have "buck-fever" in the darkroom. Simple movements and acts that you have made without thought a thousand times and more assume an overpowering importance. The mixing of the developer, taking its temperature, the preparation of the fixing-bath become ceremonials. A crack you had never noticed before sends a ray like a searchlight through the darkness. With trembling hands you remove the plate from the

holder and place it gently in the developing-tray, then suddenly wonder with dismay whether the emulsion was up or down. Developing by time you ask was it 3.08 or 3.13 when the plate was immersed? When the required six minutes have passed, you decide to give one more for good measure, then feel carefully through the ocean-like expanse of the tray to find the plate, confident that you will scrape a trail through the surface with your finger-nail.

After the longest seven minutes of your life the plate is transferred to the hypo bath and you determine to leave it there until it has fully cleared, but find yourself lifting it out for a peep almost before its edges are dark. If this glimpse tells you that the creature of your heart's desire has been captured, you replace it carefully and with a relaxed feeling of contentment go out of the darkroom to give full expression to the joy experience has taught you to hold in check until the day of achievement arrives. Then, as I have said in my opening paragraphs, it is well for the sake of your reputation for dignity and sanity to be alone!

But the end is not yet; simply all is well so far. The plate must be washed, dried, and printed, and until the last operation is completed a score of accidents may befall it. While it is washing you visit it every few minutes to watch for threatening frills or

ominous blisters; while it is drying you feel that you should sit up with it to protect it from cockroaches or possible earthquakes. It's nerve-wearing work, this flashlight photography in the tropics!

I am often asked whether, with a second camera, it would not be possible to photograph an animal's reaction when it fires the flash. It can be done, it has been done, but I do not want to do it. I do not believe that we can realize what a shock it must be to these timid, highly sensitive creatures to be flashlighted. It is difficult to conceive of a more terrifying experience than this sudden encounter with a blinding glare of light and cannon-like report at a distance of ten to twelve feet. This is the one objectionable feature of flashlight photography.

The charm, as well as the value of these autophotographs is their portrayal of the unsuspecting animal as it prowls the forest on its nightly beat. To yield to our curiosity to see "what happens" is to destroy this feeling of seeing unseen and at the same time to take an unfair advantage of the animal. It is bad enough to give an animal the scare of its life; to photograph its uncontrollable response to the impulse of fear is adding insult to injury.

The first flashlight I secured on Barro Colorado was of a Puma coming head-on to the camera. It was made January 2, 1927, on the Snyder-Molino Trail,

just beyond its junction with the Shannon Trail, and supplied the first evidence of the presence of this species on Barro Colorado since the establishment of the laboratory on the island. A large cat seen by Frank Drayton, the resident caretaker, two years previously in a low tree near the laboratory had been identified from his description as a Jaguar. But on seeing prints from the Puma negative Drayton declared that the animal seen by him was of the same species. It had climbed the tree, presumably for a better view of the two tame Brocket Deer that were tethered near the building. The animal photographed appears to be not fully adult. In my opinion the same animal was trapped again on March 10, 1927, on the Drayton Trail between Nos. 6 and 7, distant nearly a mile from the place where it had sprung the trap about three months before. I base this belief on the general appearance and similar size of the two animals, and on the white flecks in its pelage.

During January and February, 1927, three additional Puma pictures were secured, two on the Wheeler Trail (Nos. 14 and 17) and one at No. 12 on the Allison Armour Trail. All apparently represent different individuals. There were, therefore, between January 2 and March 10, 1927, not less than four Pumas within a radius of half a mile from the tower on the summit of the island.

A Fully Grown Puma

The animal appears to be stalking prey. Wheeler Trail, No. 14

Through the Peace of the Night

An adult Puma on the Armour Trail. The following night the banana tied to the trip-wire, over which the Puma is stepping, was taken by a Tapir

In 1928 I devoted more attention to camera-trapping than in the preceding year. Localities where I had before been successful were covered again and new ones were added. The trails were dragged with meat and also with essence of catnip and vials or bits of cotton saturated with this cat-lure were concealed beneath the trip-wire.

That there were large cats, either Puma or Jaguar, doubtless the former, on the island was proved by the discovery of their tracks on several occasions. We found also excreta containing remains of Agouti and White-tailed Deer. How many animals this evidence represented it is impossible to say but they all evaded the camera.

In 1929 the same two traps heretofore employed were constantly on the trails. No catnip was used in this year or in 1927. Tracks were reported in December. A flashlight of a Puma was secured on the Lutz Trail, March 17, and Donato reported seeing a Puma pass beneath the window of his house on the night of March 21. This constitutes the Puma record of the season.

While a large amount of negative data is required to be of positive importance, I feel that the taking of five Puma pictures in 1927 and of but one in the two succeeding years cannot be attributed merely to the luck of the chase. I confess, however, that I am

unable to offer a plausible explanation for the failures of the second and third years.

The shock of being flashlighted might induce so wary an animal to change its haunts, but I cannot believe that it would prompt it to leave the island. If my identification is correct, the animal photographed January 2, 1927, was still on the island March 10, following. It is difficult to think of any other cause which might tempt them to go to the mainland. The island offers them Peccaries, Coatis, Agoutis, Iguanas, and Pavos in abundance as well as protection from the hunter. It seems, indeed, a veritable Puma Paradise.

At least four of the five animals photographed in 1927 appear to have been in excellent physical condition and their pictures give no indication of decadence through possible inbreeding. There is, therefore, no reason to believe that they were not living, at least in 1928.

I do not know myself, and I have been unable to learn from others, whether Pumas and Jaguars occupy the same area amicably. If they cannot, and a Jaguar should have chanced to come from the mainland, I assume that the Puma would be the one to retreat. This, however, is pure theory; unless, therefore, it is the habit of Pumas to cover large areas and cross wide stretches of water in their wan-

derings I am unable to account for the apparent decrease in our Puma population since 1927.

My experience with the Ocelot has been equally puzzling. At 2 o'clock on the morning of January 8, 1927, from the Termite House, where I was spending the night, I heard the report from a trap set at No. 16 in the Drayton Trail. It was sprung by the Ocelot shown on the accompanying plate. The same night a second Ocelot sprung the trap set at the end of the Wheeler Trail. These are the only Ocelot pictures made on the island. The capture of these two animals on the same night is, of course, a coincidence, and their failure to recur is possibly due to the rarity of the animal on Barro Colorado. It happened that these two Ocelot plates, with that of my first Puma, were developed in the same tray, a rather large bag for a beginner in flashlight photography! With three months ahead of me I saw myself in possession of an unequaled series of photographs of tropical American *Felidæ;* but, as the result has proved, it is not well to count your cats before they are caught.

The stand which yielded the larger of the two Ocelots also gave me, a few days later, two views of the White-lipped Peccary, or Puerco del Monte. At this date this species had not been seen on the island. On the other hand, the Collared Peccary, or Zagino, next to the Coati, is the most common of the larger

mammals of Barro Colorado. It is frequently encountered in bands of from three or four to twenty, but the usual number is about eight to twelve. It is so far from shy that I know of a number of instances on the island in which men who encountered Peccaries have yielded the right of way. It is true that they did not argue the point, but it is equally true that the Peccary seemed more than willing to press his case.

It is my belief that Peccaries have a highly developed sense of smell but poor eyesight. If one approaches them from windward it is probable that they disappear unseen. But if one comes up the wind he may be within a few yards of them before they seem aware of his presence.

At the end of January, 1927, for five successive days, six Collared Peccaries fed on the hillside in the clearing immediately below and east of the laboratory. They fed on fresh growth of various plants and shrubs, often holding them down with their feet. They were there from one to two hours in the morning and again late in the afternoon. If I approached them quietly from the leeward, they permitted me to advance to within forty feet and watch them indefinitely without showing any evidence that they were aware of my presence. If, using the same caution, I advanced toward them from the windward

An Ocelot on the Drayton Trail
The picture was made at 2 A.M.

An Ocelot at the End of the Wheeler Trail

The animal appears to be following a scent

they retreated to the forest when I was still distant some sixty feet.

While sitting quietly on the upper steps of Redwood House I have seen a Peccary, feeding, come slowly from the forest into the clearing, where it soon sniffed the air. It gave no sign of seeing me; its suspicions were aroused not by what it saw but by what it smelled and it retraced its steps to the forest.

When approaching Peccaries from the leeward, their presence is sometimes betrayed by an unmistakable, characteristic musty odor. On one such occasion, I encountered a band of ten or twelve, including a mother with a young one about a foot in length. In evident response to a warning note, the little one remained motionless at a distance of about thirty feet while its mother, dorsal bristles erect, approached to within fifteen feet of me, first from the right then from the left, apparently trying to get my scent. Then it gave the alarm and with its offspring scampered off through the forest. When undisturbed and feeding, the voice of this Peccary is suggestively pig-like, but its sudden alarm-call is more of a bark than a grunt.

It is an interesting fact that, although I have seen Collared Peccaries on innumerable occasions, and have yet to see a White-lipped Peccary, it is the latter which is more frequently flashlighted. Indeed, I

have secured only two pictures of a Collared Peccary, each of a single individual, while of the White-lipped species I have numbers of exposures, including one of suckling young and another showing five animals on a single plate.

Primarily I account for this difference between failure and success by the fact that the Collared Peccary appears to be chiefly, if not wholly, diurnal, while the White-lipped is largely nocturnal. Whether it follows that the diurnal species has keener vision and is, therefore, more likely to see the camera and avoid it I am unable to say. But it is true that, although the Collared Peccary often crosses the trail, it rarely follows it. The White-lipped, on the contrary, appears to use the trails and hence more often encounters the trip-wire stretched across them.

There are evidently occasions, however, perhaps connected with the mating season, when the White-lipped Peccaries on the island gather in a large band that moves by day. Donato, our resident caretaker, is a native of Chiriqui and has been in the employ of the laboratory for five years. His veracity is above question and in many instances we have had reason to marvel at the accuracy of his observations. When, therefore, Donato states that in August, 1927, a band of several hundred "Puerco del Montes" twice visited the vicinity of the laboratory we have

no reason to doubt his word. They were first seen near the brook below the Oropéndola tree, and within a week appeared on the Lutz Trail and the two short-cuts leading from near the clearing to it. They were in the latter place for about an hour and from the steps of my house he saw many of them pass into the forest over the Snyder-Molino Trail.

This observation gives us some conception of the number of White-lipped Peccaries that there is every reason to believe are still on the island, and yet during my four seasons here I have no record of one being seen. Where do they keep themselves? It is this, the larger of the two Peccaries, that when in these large bands may be a dangerous animal to encounter.

Comparison of the pictures of Puma and Ocelot with those of the Peccary reveals somewhat of the character of these animals in their attitude toward the trip-wire. The cats, it will be observed, have, in every instance, stepped over the wire with their foremost foot, either because they see it or are otherwise made aware of its presence. But the Peccary makes no effort to avoid the wire, either because he does not see it or, pig-like, butts stolidly into it.

Not one of the animals that have automatically recorded themselves as present on Barro Colorado has given me a greater surprise or more real satis-

faction than the Baird's Tapir who on the night of February 25 or 26, 1927, in a spirit of welcome, if unpremeditated, coöperation pulled the banana tied to the wire of the camera set at No. 12 on the Allison Armour Trail. The trap, having remained for some time unsprung, was baited with this fruit; subsequently a Puma tripped the wire, ignoring the bait. This made it improbable that another Puma would soon pass that way, and the banana was, therefore, not removed. Two or three nights later the trap was sprung again. The bait was partly eaten but the wire was not broken. Experience almost conclusively indicated that I had captured a Coati. This was too common an animal to call for an early visit to the darkroom and, while waiting for other exposures, the plate was practically forgotten. Developed, after several days, in the unquestioned belief that it would yield merely another Coati picture, it was not removed from the hypo bath until it was fully cleared. Then the sudden transformation of a mental Coati into an actual Tapir picture was as unexpected as though the animal itself had entered the room.

I have also photographed a Tapir at No. 3, on the Miller Trail, and it seems probable that these animals cross the island. They also follow the courses of the brooks, but in the dry season their tracks are most

A Tapir Takes a Banana

On the preceding night a Puma passed this way. (*See plate facing page 207.*)

A Tapir Portrait

It is not clear how this flash was fired. Made on the Miller Trail, No. 3. Tapirs apparently use the trails to cross the island.

frequently found when the lower water-level exposes a bit of shore along the border of the lake. Examination of almost every favorable place of this kind, practically all the way around the island, will reveal evidence of the more or less recent occurrence of Tapir. Refer, for example, to the description of the one photographed on the Wheeler *estero*. It may, therefore, be called a comparatively common member of Barro Colorado's fauna, but so shy is it that, in spite of its size, it has not yet been seen on the island.

Less spectacular than photographs of Puma or Tapir, but equally interesting zoölogically, are several pictures I have secured of fruit-eating bats. They come readily to a banana bait which is best placed on the trail on each side of the trip-wire and several feet from it. In flying from one banana to the other the bat then comes in contact with the wire. This result is at variance with the classic experiments of Spallanzani who, after closing bats' eyes with varnish, released them in rooms across which had been strung numerous silk threads, which the flying bats avoided.

The bats employed by Spallanzani, however, were insectivorous, and to capture their prey on the wing at and after nightfall doubtless have a far more highly developed sense of "apprehension" than fruit-eating bats possess. The food of the latter is

stationary, and its capture calls for no such display of agility and what might be called "presponsiveness" as are shown by the species that feed upon insects.[1]

Agoutis are common, but these timid little creatures appear to be so constantly on the alert and so suspicious that I have photographed but a single individual. Moreover, they are so small that unless a trap were baited they might pass beneath the trip-wire without springing it. Baited traps, however, were so often fired by Coatis that the use of bait was finally abandoned. Of these animals I write at length elsewhere; to the camera-trapper on Barro Colorado they are a pest. Omnivorous in habit, active by day as well as at night, they come to our bait at any hour.

Of many smaller animals which can be flashlighted only with the use of bait, I have thus far captured the images of only an Opossum[2] and a Spiny Rat.[3] Of the larger terrestrial mammals known to exist on the island, only the Deer have escaped the camera-trap. They are, however, exceedingly rare. During my four seasons, covering a period of twelve months, I have seen only one Brocket, an adult male, and one White-tailed Deer. The former, as a true forest Deer, is at home here; the occurrence of the latter,

[1] See Anthony, "The Bat," *Natural History*, 1925, pp. 560–570.
[2] *Didelphis marsupialis.*
[3] *Proechimys* ? sp.

A Bat on the Armour Trail

Like the Tapir, which passed here, it was attracted by a banana

A Bat (Artibeus) Fires the Flash

The trip-wire crosses the animal's wings. Somewhat enlarged.

Opossum

Reflecting its disposition, the animal has settled down to eat the bait comfortably

Agouti

An exceedingly timid animal; it takes the bait cautiously

Two Pictures of Temperament

an open-country or savanna species, was unlooked for.

In 1927 I tried to attract Deer by placing large pieces of rock salt in eight different places, but I could not discover any evidence of their having been visited.

The larger terrestrial mammals recorded from the Canal Zone, but as yet unknown on Barro Colorado, include the Jaguar, Great Anteater,[1] Little Raccoon,[2] Crab-eating Raccoon,[3] and Paca,[4] or Conejo Pintado, as it is locally known.

Accounts of the Jaguar so often speak of its cry, it seems probable that if this animal were on the island, sooner or later we should have heard its voice. But, so far as I am aware, no one has enjoyed this experience. The Jaguar, therefore, is first among the possible prizes awaiting the flashlight photographer on Barro Colorado.

I have never seen the Great Anteater, but all that I have learned of its habits indicates that it is an inhabitant of campos and savannas rather than of forests. Goldman records a specimen "said to have been killed in the forest near Gatun." But it is evidently a very rare animal in the Canal Zone, and I do not believe that it exists on Barro Colorado.

There seems to be no reason why the Raccoons,

[1] *Myrmecophaga tridactyla centralis.*
[2] *Procyon lotor pumilis.*
[3] *Procyon cancrivorus panamensis.*
[4] *Cuniculas paca virgatus.*

both of which, according to Goldman, are known as "Mapachin," should not visit the island, but the presence of these animals is, as a rule, so easily detected that if they are with us they assuredly are not common.

When the camera-hunter has captured all the known terrestrial mammals on Barro Colorado, I commend to him the arboreal species. He could not ask for a greater prize than a full-face portrait of an old male Howler!

There are also birds to picture, both on the ground and in the trees. The photograph of Ghiesbrecht's Hawk eating a fishhead and of a Turkey Buzzard "reaching for the meat" are suggestions of what may be done in this field. I have also secured an unsatisfactory picture of the larger Tinamou. George Shiras, 3d, in the *National Geographic Magazine* for August, 1915, gives a flashlight of Wood Rail made in the Canal Zone. It might also be possible to get Wood Quail and other shy species of the forest floor. In fact, the limit of animal subjects for the photographer is determined only by the fauna. I have successfully flashlighted leaf-cutting ants, while the last picture I secured on Barro Colorado was of a no less important species than *Homo sapiens*. Set for an animal lower in stature, as well as in the zoölogical scale, the camera caught him only below the belt.

White-lipped Peccaries on the Drayton Trail

Compare with the Ocelot picture made at the same place and note how differently the two animals approach the trip-wire

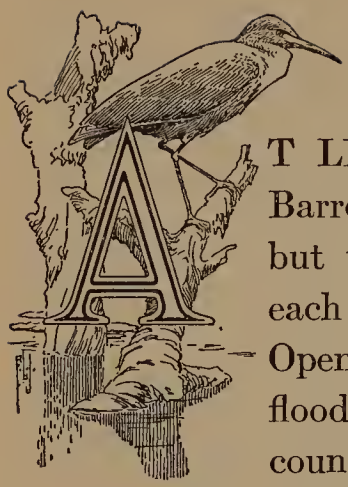
The Camera-Trap

The camera is in the center; the battery and flashlight with which the trip-wire is connected, at the right; the auxiliary flash, at the left. (*See page 199.*)

The Camera Traps a Man

A trespasser on the island left this record of his visit. He will doubtless recall the incident

Beyond the fact that he was a trespasser on the island who had inadvertently walked into a trip-wire, we were, therefore, unable to determine his identity. In *this* instance I should have welcomed a second camera to record the reactions of a no doubt very much surprised mammal.



CHAPTER IX

CAYUCA WAYS

AT LEAST a geographic knowledge of Barro Colorado's trails may be acquired, but the waterways are uncharted and each voyager steers his own course. Open shoreline, coves, lagoons, esteros, flooded barrancas, the passages between countless newly formed and growing grassy islands—each has a character and offers possibilities of its own.

A launch would be as much out of place on these waterways as an automobile on the trails. A dugout is the craft in which to traverse them. Whether it be an Eskimo in his kyak or a Panamanian in his cayuca, a native canoe seems to establish closer relations between its occupant and his surroundings than any other means of locomotion. Step as carefully as I may in the forest, and sooner or later there is the sound of rustling leaves or snapping twig; but once in a cayuca and I slip through still waters as quietly and easily as though together we were some aquatic animal.

One may embark on his voyage of exploration from the laboratory pier and, so different is the forest when

seen from the water, that he will find a new land with the first stroke of his paddle. but on this, the canal side of the island, the shores are washed by the waves of passing steamers. They create commotion where one seeks quiet, and the steamers themselves destroy the sense of seclusion. It is far better to go to the other side of the island. There the voyager will find two small houses ready for occupancy—Termite House at the end of the Drayton, Redwood House at the end of the Allison Armour Trail. Each is furnished and always fully provisioned.

These snug little dwellings were erected not alone to shelter naturalists who wished to work on the southern side of the island but to demonstrate the powers of their timbers to resist the attack of termites, a fact in no way detracting from their habitability. At the end of four years they are nobly holding their own, to the confusion of their enemies and the delight of their friends. May they live forever! In their remoteness and isolation I find the very essence of life on Barro Colorado. I am thrilled by the possibility of meeting no one. Nothing mars the peacefulness of my surroundings; there is no apprehension of interruption, no "second shoe" to drop; no "peacock" to scream. My spirits rise in the freedom of solitude.

TERMITE HOUSE AND THE ESTEROS

The Termite House is not a handsome structure nor is it attractively situated, but as a means to an end it could not be improved upon. It is placed at the mouth of the estero that leads to the end of the Wheeler Trail, and one has only to paddle around the point to the west to reach the entrance to another forest waterway of nearly equal extent.

The outlook is due east over the lake, and when the sun creeps up over the edge of the world, near the Darien wireless towers, and slides through the horizon haze as though shedding its skin, it turns the polished steel surface of the water to burnished gold and strikes the eye with the force of a searchlight. The gray tree trunks dotting the lake stand like tombstones of the departed forest, and through the passage between the end of Barro Colorado and the mainland I can see steamers crossing the continent.

On the remaining three sides Termite House is surrounded by the second growth that has replaced the forest trees felled to make room for it. Small birds passing here can be more readily identified than in the forest, and occasionally there is a migrant from the north. I have just seen (February 11, 1929) a male Baltimore Oriole, a Prothonotary and a Chestnut-sided Warbler.

The dense undergrowth is the home of a Wren whose identity I have not yet discovered. He is one of the great vocalists, probably of the genus *Thryophilus*. Evidently it is not his true song season, but the fragments of song he now and then flings out so easily are so varied, so musical, so perfectly executed that while I wish for more I am grateful for little. I have had only a glimpse of him but not enough to see his color and markings. With a gun I might have learned his name, but of what use would the name be without the song? Were I merely passing through here not to return I should doubtless yield to the naturalist's desire to know at the sacrifice of life; but this Wren and I are neighbors, and some day he will reveal himself.

My most distinguished neighbor at Termite House is heard only at night. He, or she, is my great Bird Mystery (I assume that it is a bird!) whether on or off Barro Colorado. I call him "Juan" for that is what he says, but possibly it should be Juanita. This creature of remarkable voice may be introduced by a quotation from my journal of January 13, 1927:

"The moon is nearly full. The sky, earlier filled with great white, fluffy cloud-masses broken by deep blue, star-set spaces, is now clear. At intervals the breath of a breeze stirred the leaves, and the night was falling peacefully to sleep when Juan called. A

year ago I heard him and I have returned with a hope of learning his name. Although I was waiting expectantly I confess to a start when the call came suddenly from the forest just outside of my window. 'Juan,' he or she called, '*Juan, JUAN,*' with increasing volume and in so despairing and still so pleading a tone that Juan could not have heard it and kept silence. But there was no reply and the voice sank to a low moaning, long-drawn 'Ju-a-a-n' as clearly enunciated as though it proceeded from human lips. It seemed the utterly hopeless lament of one overcome by grief, I assume for the loss of Juan. From time to time the groan, long-drawn, heart-rending was repeated and on each occasion the 'creeps' ran pleasantly up my spine. Intently I watch, trusting that some ray of brilliant moonlight may reveal the mourner but the forest hides her."

On March 6 of the following year I had much the same experience and again was unsuccessful in seeing the bird. I say "bird" because on one occasion, to my relief, she passed over the house while calling. Tonight (February 12, 1929) there is no moon, but I have heard just enough to know that Juan is still being called.

It is nearly an hour before sunrise when the Howlers announce the coming of dawn. From the Termite House I have heard three clans calling at

the same moment; one on the Drayton, and two toward the Wheeler Trail. There are, therefore, not less than six clans on this side of the island.

Parrots do not appear for another half-hour or more. Were they to add their voices to the Monkeys' we should indeed have a vociferous dawn. The voice of the Blue-headed Parrot, smallest and least common of the three island species, is high and comparatively thin, and the bird may also be distinguished by its free, full wing-stroke. The Amazonas, when flying, raise their wings little if any above the level of their back. Salvin's Amazona or Parrot, may easily be known by its clearly uttered *chikák, chikák, oorák, oorák, ooerk,* repeated many times by both sexes, particularly as they fly. The Plain-colored Parrot, all green except for a touch of red in the wing, is larger and its voice is correspondingly louder. In the distance some of its notes are really musical and have a true clarion ring; but heard at close range the *yelp, yelp, yelp, cha-cha-cha* with which it takes wing makes the roar of city traffic sound like a slumber song.

Evidently their nesting season is now approaching and by far the greater number are in pairs, but several times I have seen what appeared to be the attempt of a mateless bird to "cut in," as it were. In one instance two of five birds seemed to be rival

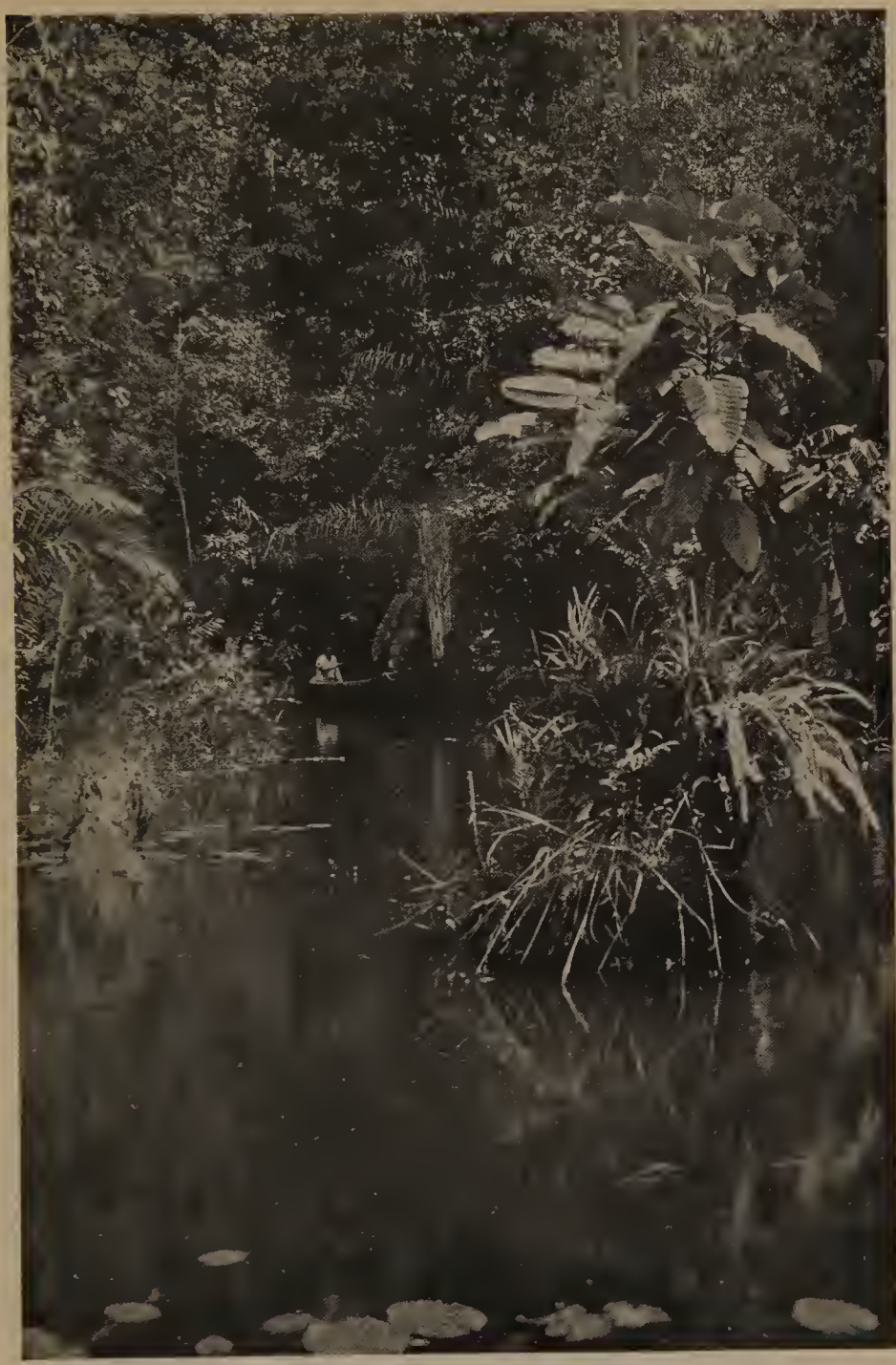
claimants for the odd bird of the remaining three. They all flew in wide circles while the rival birds tried to "ride each other off" and thus prevent a too close approach to the object of their attentions. She, meanwhile, was always at the front, evidently prepared for eventualities, but what part the extra pair played I could not determine. After circling over the lake they perched in a nearly leafless tree where the two contestants lost no time in coming to grips and, locked in each other's claws, whirled downward. This, however, did not settle the affair. The five birds again took to the air, the riding-off tactics were repeated, and so they disappeared. At other times only three birds took part in these courtship flights. The objects of the two that I assume were males seemed plain enough and equally clear was the interest displayed by the third bird, who I assume was the female. She did not remain behind to be claimed by the victor, but evidently believed that a mate near at hand is worth a flock in the forest.

Further casual observation on Parrots leads to the conclusion that an intensive study of their habits would yield exceptionally interesting results. They are apparently attracted to this side of the island by the holes found in the dead trees in the lake. At present these furnish sleeping quarters; later they may be used for nests. At 6.15 on the evening of

February 10, two Salvin's Parrots were seen flying toward a large dead tree west of the Termite House. One bird perched at the tip of a high limb; the other went direct into a hole twenty feet below. After waiting about five minutes, Number 1, presumably the male, flew back to the forest calling loudly. A few minutes later the female, or so I called her, came from her hole, and followed the course of the male, also calling. Within less than two minutes she returned alone, entered and remained in her hole. The following evening at 6.20 two birds appeared; as before, one went to the high limb, the other to the same opening. Again, after a short wait, the male, calling, went back to the forest, but on this occasion, the female did not follow. My interest was now definitely aroused; had I witnessed an incident or a habit? The third evening I took my post on the steps of the Termite House shortly before 6 o'clock to watch for the return of the birds. A quarter of an hour passed and they had not arrived. Parrots in pairs, flying, as usual, so near together that they almost touched, crossed the sky, bound doubtless for their homes. At 6.20 the Salvin's Parrots had not appeared, but two birds of their species were calling at intervals the vociferous crescendo of *chikaks* and *ooraks* that usually precedes flight, and each time I waited expectantly. At 6.25, following an exceptional out-

burst, a pair of Salvin's Parrots left the forest, distant 200 yards, and flew straight toward the dead tree. One went to the perch on top; the other bird to the opening. A few minutes later he returned to the forest; she remained. It looked now as though I had discovered a habit. If so, what was its significance? The purely sentimental observer might find here material for some touching verses on "Seeing Polly Home." I was almost tempted to write them myself! But they would not answer my question. Science as well as sentiment must be satisfied. An observation made the following morning contributed to both these ends. At 6.25 a Parrot, I think one may say the male, came over his accustomed route toward the tree. When he was still fifty feet away the female flew out to meet him and together they went back to the forest. Evidently he was expected. Here was material for several more verses! Also here was an indication that the birds were paired (or at least engaged!), but that actual housekeeping had not yet begun.

It was March 24 before I again returned to the Termite House. Six weeks had passed since I had first seen Salvin's Parrot so gallantly escort his presumed fiancée to her home. If true love had not been diverted from its course they should have been making history. At 4.45, when I arrived, a Salvin's



The Haunts of the Tapir

The Tapir shown on the following plate was about to climb the bank beneath the wild banana leaves that overhang the bow of the canoe

A Tapir Emerges

When swimming he was evidently submerged at least to the eyes. The trip-wire crosses the "bridge" of his nose

Parrot was perched at the top of the Parrot's tree. Fifteen minutes later his mate left the hole and together they flew to the forest. At 6.09 both birds returned and perched in the tree-top. Two minutes later one entered the nest, remained four minutes, rejoined her mate, and again both left for the woods. Were there young in the nest and had she fed them? At 6.30 they returned. The leader went to the tree-top, the second bird flew straight to the nest. There she remained and three minutes later he flew to the forest.

Although I began my vigil the next morning at daybreak, the forest bird must have come for his nesting mate when my back was turned, for at 6.50 both birds appeared from the west. After perching quietly for a minute, one regurgitated food into the mouth of the other. Three times this operation was repeated, then the fed bird went to the nest and the feeder to the forest. Had he helped bring home the children's breakfast and delivered it to his wife on the doorstep of their dwelling? Here my observations for the season ended but so far as they went they convinced me that power of speech is not the only human-like attribute of Parrots.

As the sun rises the lake loses much of its beauty and I leave the glare from its surface for the seclusion and shade of the estero. The forest, with its feet in

the water, its head in the sunlight, its bayou side uncrowded, free to expand, responds to the combined influences of moisture, warmth, and air and expresses itself with a luxuriance unknown in its depths. It is not a monotonous wall of green; there is no sameness, no community of growth, but endless diversity of form and wide range of color, with high lights from shining masses of cascading vines and deep shadows in the openings that give glimpses of smooth, gray trunks within. And this overpowering richness of growth is doubled by the dark, still waters of the estero.

As one paddles over the narrow waterways between these high walls of vegetation that in places meet overhead, he has a feeling of being watched, as through partly closed blinds. Whoever is on the other side of that screen of leaves has all the advantage. He is invisible while I, no matter how quietly I slip over the water, might be a procession passing before his door.

Basilisks, surprised on some outstanding stump, scamper with a patter back to land; Iguanas drop with a "belly-whopper" flop into the water or with a scurry of rustling leaves, rush up the bank. Rarely a Crocodile slides sullenly from a mudbank into the estero with a surging wave that rocks the cayuca. Anhingas, looking like attenuated Cormorants, pose

on stumps or drop into the water to disappear or swim with only their snake-like head and neck exposed. The cayuca is so much a part of the place that a pair of Pied-billed Grebes came to the surface almost under my bow to find that what seemed like a floating log was inhabited, when, with unusual commotion, they submerged again. Two Marmosets were breakfasting among the blossoms of a balsa on the bank. One took a great ivory cup in both hands, whether to drink from it or eat the flower itself I could not tell.

Then into this miracle of greenness came Morpho, the great blue butterfly. It is the bluest thing in the world; the sky pales before it; no gem can match it. In solitary state it flitted along the shore, pausing here and there as though reviewing its subjects. Every plant stood at attention; every leaf saluted.

But all these are on the outer side of this green wall, and I still look for a sign of life within. Perhaps through some open doorway I may learn who has entered; so I watch the banks carefully for signs. Tapirs seem to be the only animals that use these water entrances. I have yet to find any evidence that Ocelots, Pumas or Peccaries cross these esteros, and if they avoid a stream a few yards wide it does not seem probable that they would swim to the mainland. But Tapir tracks are not infrequent. Here,

like some cow, they have slipped down a steep bank, crushing the vegetation; here ascended a more gentle slope, in either case leaving signs that may last for days.

It was the ever-observant Donato who, while on a tour of inspection, found a place on this estero nearly opposite the end of the Wheeler Trail where, apparently, on the preceding night, a Tapir had come down the bank, swam the estero, here about thirty feet wide, and entered the forest on the opposite side. Here seemed an admirable opportunity to secure a picture of a Tapir that would illustrate his aquatic habits. The one I had captured near the summit of the island, eating a banana as he pulled the string that fired the flash, was excellent in its way, but it seemed more like a caricature than a picture which filled one's ideal of a Tapir in its haunts. So both flashlight cameras were taken from their patient watch on the trails and with no little trouble set where it was hoped they would capture the Tapir. I used especial care with the one set to guard the trail whence the animal had left the water and over which I expected him to return; for it was my belief that the reception accorded him here, as the flash exploded, might disturb his routine, when the camera on the opposite bank would not be called upon to function.

A stump at the water's edge supplied a point of attachment for one end of the wire, which was then run over the water, about a foot from shore, to a stake whence, through a staple, it was guided to the battery placed with the camera on the bank above. A heliconia leaf, arching over the water, helped give balance to the prospective picture. The position selected was designed to give a full profile view of the Tapir entering the water.

Wiring, electrical connections, focusing, shutter-setting, slide-drawing, the crucial locking of the switches, were all carefully reviewed. There was nothing more to do. The next move was "up to" the Tapir. He made it promptly. The next day the wire was found broken. I could discover no signs of an animal having descended the bank, but in view of the broken wire that was an unimportant detail. At this point the responsibility that besets the animal flashlight photographer took possession of me. The preceding day, after setting the camera, I had found no difficulty in dropping down the bank into my cayuca; but now I had a potential Tapir in my game-bag. It was not the weight of the Tapir that troubled me, it was the weight of the responsibilities his possession implied. If the elusive little craft deposited me in the estero I would be none the worse for the wetting, but Tapirs on photographic plates

are not so impervious to water as are the originals. However, the canoe was safely entered and left, the dangers of the darkroom were encountered without mishaps, and the result of the entire adventure is presented herewith.

It will be observed that the Tapir was going in exactly the opposite direction to the one anticipated. I had expected him to enter the water; instead of that he left it. But if I am a failure in reading a Tapir's mind he scored a success in reading mine for he gave me exactly the picture that my imagination had drawn. The bank here descends so abruptly that eight feet from shore the water is five feet deep. The water dripping so realistically from his nose shows that when swimming the animal was submerged at least to his eyes. Touching bottom with his forefeet he had started to ascend just beneath the wire which may be seen crossing the tip of his nose.

Returning to Barro Colorado the following year, I went to pay my respects to the Tapir of Wheeler estero—or at least to the scene of our vicarious meeting. The heliconia leaf had gone the way of all leaves, but there was the stump, there was my guide-stake with its friendly looking staple, and there were Tapir tracks! They were not very fresh but they were unmistakable and welcome evidence that the events of the preceding year had not driven Tapirs

from the vicinity. I deposited a banana as a thank-offering. The next morning it had gone, I hope down the opening beneath that overhanging, dripping nose.

REDWOOD HOUSE AND THE GRASSY ISLANDS

Redwood House is a mile west of Termite and faces the same drowned valley. It fits its small clearing snugly, cosily. The encircling forest has accepted it as though it were a living representative of the trees from which it is made. Through its four windows one can keep close watch on his surroundings. The high, hooded stoop gives one a wide outlook over the lake. A short pathway leads to a well-constructed landing from the end of which I can see the sun set; a few yards farther out, from my cayuca, I can see it rise. Earth, air, sky, and water combine to make these phenomena of such exceptional beauty that I await their advent as eagerly as though they recurred at yearly, instead of daily intervals. I have a feeling of something pleasing and unusual to come in the near future and discover, after a moment's thought, that it is the sunrise or sunset.

Near the southwestern extremity of Barro Colorado a peninsula projects southward toward one extending northeastward from the mainland. The passage between the two is about 250 yards in width. This is the closest approach of the southern shore of

Barro Colorado to the mainland. Comparison of existing and earlier conditions, as they are revealed by charts, shows that land is forming here, and unless the frequent journeys of launches with their tows of banana barges will keep this passage open, it is probable that some day these points may meet.

To the windward of this strait, looking toward the main body of Gatun Lake, the water is thickly dotted with still-standing dead trees of the pre-canal forest, but there are no islands. To the leeward of the strait, protected from the full force of the north-easterly trade winds by the island and its peninsula, the entire water area on the island side is a maze of islands as far as Redwood House. On the mainland side, and to the eastward, there is more open water, though islands are by no means lacking.

The islands vary in size from a stump-top to several acres. The channels separating them range from a few feet to several hundred in width. Near Barro Colorado they are from five to ten feet in depth, but soon increase to thirty-five or forty feet as the main channel, or bottom of the valley, is approached.

The islands are formed chiefly on the trunks or limbs of trees which have broken off on or near water-level and, to a lesser extent, on floating debris. Their flora is developed through various associations.[1]

[1] See Kenoyer, *Ecology*, 1929, pp. 216–219.

Redwood House

Located at No. 3 on the airplane view of the island. The photograph facing page 189 was made from its steps

An Immature Jacana

(Photographed in the gardens of the Experimental Farm at Summit, C. Z.)

The Grassy Islands

Every island, stump, and skeleton tree has its inverted double

Where a stump projects above the water, cat-tails take possession of it. In many instances the foundation for the new land is laid below the water by the bladder-wort (*Utricularia mixta*). When this plant becomes a dense mass, streaming to leeward from its attachment, a stiff, wiry, deep-rooted sedge (*Fuirena umbellata*) appears, whether by germination of its seeds or the stranding of floating stalks I did not discover. Soon a giant fern is added to the flora; this is followed by cat-tails and the whole becomes overrun with a convolvulus and adorned with clusters of sagittaria and mallow. Through this succession of growths the islands continue to increase their domain. *Utricularia* leads the way, advancing under cover of the water; the highly mobile sedge follows to prepare the ground for the consolidating ferns and cat-tails.

Given an anchor and protection from the wind, it is obvious that depth of water is not a factor in the origin and development of these new bits of the earth's surface. The water below them is frequently thirty-five feet or more deep. Except in shallow places it is doubtful if many of them touch bottom. To say whether these islands will some day fill certain parts of the passage between the island and the mainland calls for a more intimate knowledge of the factors governing their growth than I possess. Certainly they have made a good showing in the fifteen

years since the area they occupy was flooded. Meanwhile they have added a marsh to our forest and thereby increased our flora and fauna.

About an hour before sunrise, when I open my door, the Southern Cross hangs squarely before me and is reflected in the water off the landing. Both to the east and west Howling Monkeys are calling. I can even hear a clan in a mainland forest nearly two miles away. Their roar is continuous. They seem responsive to the first indications of daylight. Guans beat their drums and the large Tinamous flute richly. One morning a pair of Wood Rails sang a duet just outside my window. The two parts were quite unlike, one being more elaborate and with at least three times as many notes as the other. But they had the same rhythm and harmonized perfectly. It was a quaint performance. I seemed to be listening to an aged couple singing in shaky, quavering voices a song of their youth.

The lake is like blue-black glass. The air rapidly becomes luminous with a diffused golden light. I enter my cayuca; the slightest pressure on the long, pointed paddle sends the graceful boat slipping over the liquid glass with scarce a ripple. A dozen openings to the islands invite me, and I am soon lost in a labyrinth of water-glades and channels. The morning-glories have not yet opened their eyes; the pond-

lilies are still close-wrapped in their green night-robes. Every island, stump, and skeleton tree has its inverted double; I float at the level where the

Wood Rails

two meet as though suspended—like Mahomet's coffin. An ominous scraping brings me back to earth and I discover that I am paddling through the branches of a forest tree.

There are not many birds. A newly formed marsh does not become as quickly populated as a recently made field. But the place presents an interesting opportunity for a study in colonization and adaptability to what, in some respects, are unusual conditions.

Parrots, talking loudly, sit outside their sleeping-quarters in the dead trees, perhaps to plan the day's campaign for food. Their clarion calls and harsh screams are the dominant bird-notes. Before the sun has risen, as well as after it sets, the little White-throated Bat Falcons use these trees for sally-ports from whence to launch their attacks. Moths seem to form the greater part of their food here. They hunt by coursing and also by watching from their perch. In their stout, powerfully built bodies and long wings they resemble their relative, the Peregrine; in their agility they rival a Barn Swallow. I have never seen any other bird exhibit such command of the air. Their speed is a challenge to the eye to follow their course, and when in full flight they make right-angle turns with an abruptness and consequent strain that would wreck an airplane.

Their power of sight is no less remarkable than their power of flight. In the dim light of their feeding-hours they pursue their, to me, invisible prey, seen, not against the sky, but over the dark water,

and the moth wings which drift down from their perch, and which I pick up from the water, are evidence of their success. Soft, mottled, neutral-tinted fragments they are, but motion cancels the protective value of any color or pattern.

A Bat Falcon and His Prey

Cormorants are more at home in these waters than any other birds. They roost in flocks in the dead trees, their funereal appearance in harmony with the gaunt, skeleton-like branches. How different are their elongate bodies, black colors, and inarticulate, raucous notes, from the chubby forms, bright colors, and vociferousness of Parrots! Certainly in the day when these birds were dominant types there was wide diversity of bird-life.

Gray-breasted Martins give a more cheerful note to the dead trees. They are here in numbers and may be nesting. This morning a group vigorously and

effectively attacked a large, blackish Hawk that chanced to pass within their territorial limits. The Martins swarmed about him, at times alighting on his back where they were as much out of his reach as a tick between one's shoulders. A stop in a tree brought no respite, and he finally reached the shelter of the forest a much-harried and, possibly, wiser bird. The Martins, with loud, excited calls, returned victorious to their gaunt stronghold.

A Yellow-breasted Kingbird[1] frequents both the dead trees and stubs, and nearer shore three smaller species[2] are common. Here also are found the Isthmian and Ringed Kingfishers, one about half, the other more than double the size of the northern Belted Kingfisher. The former has a flight-call like a string of beads. The latter looks like a giant edition of our species and its rattle is loud in proportion to its size. Every evening, shortly after sunset, a single bird flies over at a height of nearly two hundred feet, calling at frequent, regular intervals a loud *chack; chack.* I identified him only by exclusion; he looked more like a Crow than a Kingfisher.

The marsh proper offers even greater difficulties to the bird-student than the tall trees of the forest and dense undergrowth of its margins. A bird may

[1] *Tyrannus melancholichus.*

[2] *Pitangus lictor; Myiozetetes cayennensis* and *M. similis.*

call within a yard or two of you but be as invisible as a person in another room. To make a census of marsh-birds whose voices are unknown to you is the work not of days but of a season—and a breeding-season at that.

The islands have no shores; they offer, therefore, neither feeding-place nor foothold to waders. There are no Plovers or Sandpipers and only rarely a large Heron; but Little Green Herons and Least Bitterns find homes here. Their slim bodies slip through the matted vegetation like Rails and they cling to the reeds like Sparrows on a grass-stalk. In the latter half of the dry season, when the lower water exposes many smaller stubs, the Green Herons use them as stands from which to catch passing small fry.

In appearance, manners, voice, and numbers the most characteristic bird of the marsh is the Purple Gallinule. He lives in the shallower places where the water is not too deep to permit pond-lilies to grow. Among these he feeds but he is equally at home in the dense growth of the islands.

With colors a Hummingbird might envy, he has the vocabulary of the hen-yard, the habits of a Rail, and other attributes distinctively his own. His bill is scarlet, tipped with yellow; he wears an azure shield upon his forehead; his neck and lower parts are rich indigo-blue; above, he is brilliant green

washed with old gold, his feet are bright yellow, and his lower tail-coverts are snowy white. While concealed in most birds, in life, they are the Gallinule's most noticeable feature.

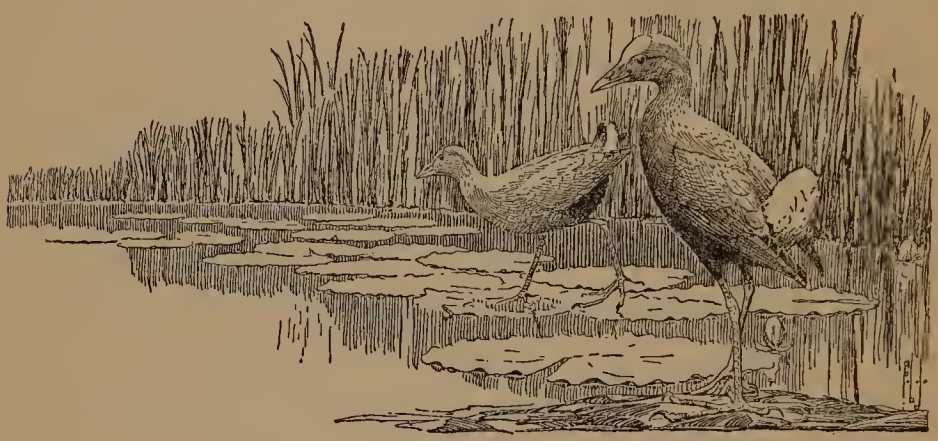
Darker below than above, he violates the fundamental Thayer law of color-gradation in relation to the source of light and cheerfully upsets all our theories of protective coloration by seeking the most exposed places and, by his actions, making himself as conspicuous as possible. See him, with almost the skill of a Jacana, stepping daintily over the lily-pads. In places he hurries, as over thin ice, but usually broad leaves and the vegetation below them support his weight. His bright red bill shines like a signal, his body colors glisten in the sunlight, every step is emphasized by his large yellow feet; but as though this combination were not enough to invite attention, he raises and lowers his tail with a nervous twitching motion and with each twitch flashes his wide-spread, snowy, under tail-coverts. He might be heliographing to some one in the rear. Nor do his attempts to exhibit himself end here. At times he mounts a stub a foot or two in height, and, spreading his wings and extending his neck, holds this pose by the minute. It is true that the wide-opened wings conceal the white tail-coverts, but, without a mirror, how is he to know that? Finally, when alarmed, he

seeks cover with heavy rail-like flight, his yellow feet, held forward, vigorously claw the air and his white coverts, now fluffed out like a chrysanthemum, become twice as conspicuous as they were before.

How can all this display be explained by any theory of protective coloration? It is true that every color of the Gallinule is more or less closely repeated in his surroundings—in the green of the lily-pads, sometimes brown-tinted, and the red of their undersurface, showing here and there; in the blue of the sky reflected in the water, the yellow of dead grass-stalks, and, particularly, the white of the pond-lilies which, indeed, bear so striking a resemblance to the Gallinule's lower tail-coverts that I have sometimes confused the two.

Using these objects it would, in truth, be possible to paint a picture wholly faithful to nature in which the bird could not readily be distinguished from its surroundings. But I should have small faith in the value of the result. Purple Gallinules are not always associated with white pond-lilies, nor are the lilies always in bloom or their blossoms always open. I should explain the Gallinule's survival, in the face of what we believe to be exposure to its enemies, chiefly on the basis of its alertness. When in the open it is constantly on guard. The slightest cause for alarm attracts its attention. It doesn't wait to be warned

thrice to take to the reeds. It apparently anticipates attack from below as well as from above. I have seen a bird feeding among the lily-pads suddenly spring with a chatter into the air and alight on a nearby stub. Possibly it was threatened by a Crocodile. But



Purple Gallinules

whatever be the factors that preserve the Gallinule, they are assuredly effective. Our own species is common from Florida to Paraguay, and his somewhat similarly colored relatives are widely distributed in the Old World.

But the Gallinule's efforts to reveal himself do not end with his colors, habits, and choice of haunts. He has an extended vocabulary which he uses freely. In the main it suggests many of the notes of a hen but, reflecting his more nervous disposition, he calls with greater spirit. His *tucks* and *clucks* are sharp

and explosive, and to them he adds a series of rail-like notes including so close a rendering of the *bup-bup-bup* of the King Rail that for a time I thought a representative of that species inhabited the island.

So much for the adult, but what shall we say of the downy young? No one familiar with a young Black Skimmer in nature doubts that it is as protectively colored as its parent is conspicuous. Its softly mottled plumage looks like grains of sand rendered in feathers. When it molds its body into the irregularities of the beach it becomes almost invisible and is aware of it; you may walk over it and be none the wiser.

On March 14, 1929, I saw two Purple Gallinules about a week old. They were shining jet-black and far more conspicuous than the blue and green parent they were following. Did they squat, or attempt to hide among the lily-pads? Not for a moment! They seemed as conscious of their revealing blackness as do the young Skimmers of their concealing grayness, and hurried away to cover.

Associated with the Gallinule are numbers of Jacanas. The two are alike in feeding-habits but the Jacana's lighter weight and longer toes permit it to walk with ease over vegetation which would not support the larger bird. Like the Gallinule, the Jacana refuses to conform to the laws designed to

explain the manner in which birds are protected by their colors. It is true that the dark back and white underparts of its immature plumage present an admirable example of that type of coloration on which Abbott Thayer's law of color in relation to the source of light is based. It is equally true that the bird at this age is less conspicuous than when adult. But just as Thayer demonstrated the action of his law by making the white underparts of his model as dark as the upper, so nature has treated the adult Jacana by making it either uniform maroon or wholly black, when, like Thayer's model, it is revealed by the now unrelieved shadow on its lower surface.

But its increased conspicuousness does not seem in the least to worry the Jacana. Indeed, like the Gallinule, he makes himself more easily seen, not by the use of his tail, but by the manner in which he exposes the peculiar color of his wings. The inner webs of the Jacana's flight-feathers are pale pea-green. This color is not visible in the closed wing but is conspicuously shown as the bird takes flight, when it can be seen at distances where the bird itself would not attract attention. So far very good; there are many similar types of coloration among birds and mammals which advertise the animal in motion; the white feathers in a Meadowlark's tail or a rabbit's "cotton-tail," for example. But immediately

the animal stops these marks are concealed, and their sudden disappearance is presumed to confuse a pursuing enemy who may continue to hunt for the white-marked bird or beast he was, perhaps, about to grasp. But the Jacana, instead of closing his wings as he alights, like an Upland Sandpiper usually lifts them high over his head and holds them expanded for a moment before gently folding them. He thus makes himself a shining mark at just the moment when, because he has paused, a foe might be expected to overtake and strike him. Still the Jacana, like the Gallinule, is a successful species and his *yip-yip-yip* is a characteristic note among the floating leaves of tropical lagoons from Mexico to the Argentine. As a preliminary step to a study of how he escapes his enemies it might be well to learn who they are!

Before the Gallinules and Jacanas appeared, I heard from the marshes a short but loud, groaning snore. After the lily-pad birds had retired to the grasses for the morning, I definitely placed this sound in a dense growth of ferns and grasses. It was singularly human-like in tone, the kind of a call that puts one's imagination on edge. Its author could not have been more than twenty feet from me but he was as invisible as though we had been separated by a hay-stack. The same note now came from

another island. Could it possibly be the voice of Juan? This time I got within ten feet of the caller. After many minutes of intent watching I suddenly slapped the reeds near him with my paddle but he was not startled into flight. Eventually, with Juan, he became an island mystery. Every time I came to the Redwood House I heard him, always I tried to see him, and always I failed. On one of the earlier attempts to make his acquaintance I was brought to a right-about face by a call at my back suggesting the combined efforts of an alarm-clock and watchman's rattle going off under pressure. I reacted visibly. A man without nerves would not have been startled, but he should be pitied, as we do a man without sight or hearing. For a moment the snorer was forgotten in this new mystery. But I had no better success with one than with the other. The midday wind arose; the sun on the water was glaring; the islands became formless; not a bird's voice was heard; the morning had passed.

White-throated Rail

At sunset, I returned to the place, the bird called again and was answered

by others. Finally a distant fern trembled and I got a glimpse of a small, rail-like form, but before I could see more he had gone.

The following evening I shoved the bow of the cayuca into the grass nearer the fern. Again the bird called, a frond trembled, and a small, brownish head appeared. It was no place for a glass; a quick shot and a minute later I had in my hand the body of my first White-throated Rail. A chorus of rattling alarms greeted my shot and to every one I could now attach a name. A new bird had been added to the known fauna of Barro Colorado. The record was based on evidence that no one could question and it made the taking of further specimens unnecessary.

When I reached the landing at Redwood House the western sky shone with intense, limpid brilliancy, and lake, marsh, and forest—my whole being—was illumined by the supernal light of a tropical afterglow.

CHAPTER X

THE VOICES OF TROPICAL BIRDS

ONE cannot well write of a bird or of its home without also writing of its voice. Through its notes, in other words its language, a bird may give expression not alone to its own character but it may give character to its haunts. The latter is particularly true of a tropical forest which is made vocal by its usually invisible feathered inhabitants.

What one hears, therefore, is so much more impressive than what one sees of tropical forest bird-life that the subject of birds' voices deserves a more comprehensive treatment than can be given it by casual descriptions of birds' songs as we hear them in the clearing and on the trail.

The prevailing opinion that tropical birds are largely songless is just as incorrect as the belief that, in the main, they are brilliantly colored. It is because they have sung unheard that the songsters of tropical America, at least, are unknown to fame. Here in the Canal Zone, for example, some song-birds of the highest rank have for the first time found appreciative human listeners.

But before one writes of the voices of tropical birds he should define clearly what is meant by the term "tropical." On our maps the tropics lie between north and south latitudes twenty-three and a half degrees, but in America, and to a lesser extent in other parts of the world as well, there is a vast mountainous area contained within these boundaries belonging to the Subtropical, Temperate, and Paramo or Alpine Zones, and the bird-life of each of these zones is just as deserving of separate treatment as that of the Tropical Zone itself.

It is, for example, in the Subtropical Zone, which lies between the altitudes of 3,000 to 5,000 and 8,000 to 9,000 feet, that we find most of the Solitaires (*Myadestes*). We have one representative of this genus, Townsend's Solitaire, in the western United States, and others are found southward as far as Bolivia, always in the mountains. All are notable singers, and the dark slaty blue Clarin (*Myadestes unicolor*) of southeastern Mexico may, in my opinion, claim first place among American song-birds.

In the same zone belong the small Thrushes of the genus *Catharus*. They are very closely related to our Hermit Thrush, Wood Thrush, and Veery, the leading trio of North American song-birds, and perhaps should be placed in the same genus. Most of the ten species of *Catharus* are fine songsters, and Ridg-

way remarks that the song of *Catharus frantzi*, of Costa Rica, reminds him strongly of that of the Hermit Thrush. While the tropics might claim these birds as members of her feathered choir, just as in North America we claim both the Mockingbird of the South and Hermit Thrush of the North, we will not include them in our consideration of birds which are restricted to, and hence truly representative of the Tropical Zone.

In further defining the tropics it should be remembered that there are arid tropics and humid tropics, these two primary divisions of the Tropical Zone being dependent on rainfall, particularly on the amount of rain that falls during the dry season.

The humid tropics supports luxuriant forests, the arid tropics has open growths of acacias, mimosas, and cacti, and on savannas and llanos even these may be wanting. There is a wide difference between the bird-life, and hence the bird-song, of these two climatic regions, and unless one lives in an area where they intergrade or where both are accessible he will have only a limited knowledge of tropical song-birds. Just, for example, as a resident of our plains who was familiar with the song of the Western Meadowlark might never have heard the voice of the Wood Thrush.

Some species of Mockingbirds, for instance, are

found throughout the greater part of the arid tropics. The Meadowlark, Cardinal, and a Quail that calls *bob-white* are found locally in the arid tropics as far south as Venezuela. It is in the arid, or more open tropics, that most of the Thrushes and Wrens are found, and these two families possess not only the greater number but some of the finest of tropical song-birds. Indeed, for musical quality and brilliancy of execution, the tropical Wrens allied to our Carolina Wren[1] can hold their own with any song-birds in the world. In the chapter on the Pacora Marshes I speak briefly of the songs of two members of this group, and later I shall have something to say of several species that inhabit Barro Colorado, where, unfortunately, they are not common. The great Mocking Wren (*Donacobius*) is also resident in the less densely grown part of the tropics from eastern Panama southward. In Venezuela I found it in the cat-tails bordering Lake Valencia.

The song of the tropical members of the genus *Turdus* bears a marked resemblance to that of our Robin, and some of them are better singers than our familiar species. In the Canal Zone, for example, the song of the Panama Robin, or as the books call it, "Bonaparte's Thrush," is distinctly superior to that of the northern species.

[1] Genera: *Thryophilus, Thryothorus,* and *Pheugopedius.*

It is, then, in more open growths, gallery forests bordering streams, thickets and brushy places of the arid, as distinguished from humid tropics that we shall find the greatest number of song-birds. When we speak of "tropics," however, it is usually the latter region we have in mind. Our concept of tropics calls for luxuriant forests, not thorns and cacti. It is, therefore, of the bird-voices of a tropical forest I write, and more specifically of those heard on Barro Colorado.

With this restriction it may be said at once that the bird-student from the north misses here that type of bird music which is represented by the sustained, lyrical recitative of the Brown Thrasher and Catbird or the melody of the Wood Thrush. But in their place there are the appealing trills of the Tinamous, the booming of Pigeons and crooning of Doves, the hooting of Motmots, the cowing of Trogons, the weird notes of Goatsuckers, loud cries of Guans and Toucans, screams of Parrots, whistles of Wrens and Woodhewers and piping of Antbirds.

The voices of many of these birds are singularly human in tone or form while the notes of others may be recorded on our scale or rhythmically expressed in words. What they lack in musical value they possess in character. Where a northern woods is vocal with songsters whose notes charm us with their

cheerful friendliness, sheer beauty, or spiritual quality, the prevailing tone of a chorus of tropical forest birds is weird and rather sad. The density of the vegetation, the height of the trees, the retiring nature of many of the birds, make it difficult to see the singers, and this fact adds to the mystery that surrounds them. Possibly, in time, familiarity might make all these voices stand for the birds that possess them, but to me they are still the language of a forest people, some of whom I know, while others are strangers. At the end of my fourth season on Barro Colorado I daily hear bird-notes which I have not yet traced to their authors.

Among these scores of species, which are the real songsters? To the systematist a song-bird is a member of the order Oscines or a bird in which the voice-organ or syrinx has "four or five distinct pairs of intrinsic muscles, inserted at ends of three upper bronchial half-rings, and thus constituting a highly complex and effective musical apparatus" (Coues).

But musically the merits of a bird's notes are not always to be determined by its anatomy. Numbers of Oscines, in a musical sense, are essentially songless; many non-Oscines are better musicians than birds that are technically classed as "song-birds." The Cedar Waxwing, for example, does not compare as a vocalist with the Upland Plover.

If we disregard the dictates of the systematist and attempt a classification based on the significance of a bird's notes, we admit to our list many birds that are, assuredly, not songsters. Song, in a functional sense, is primarily an expression of the mating and nesting season. The drumming of Grouse, the rolling tattoo of Woodpeckers, the booming of the Nighthawk, are biologically as much songs as the hymn of the Hermit Thrush.

If we are guided by the musical quality of a bird's performance, our estimate must be a wholly arbitrary one based on the development of our "ear for music" and our emotional responsiveness to its influences. Everyone would doubtless agree that to be a songster a bird should utter notes both pleasing and melodious. But how many notes are required to make a song? Bob-White, for example, may sing only two, but surely no nature-lover would deny him the rank of song-bird.

It is, then, from the standpoint of the nature-lover rather than that of the systematist or biologist that I attempt to name the song-birds of Barro Colorado's forest and present some estimate of their songs.

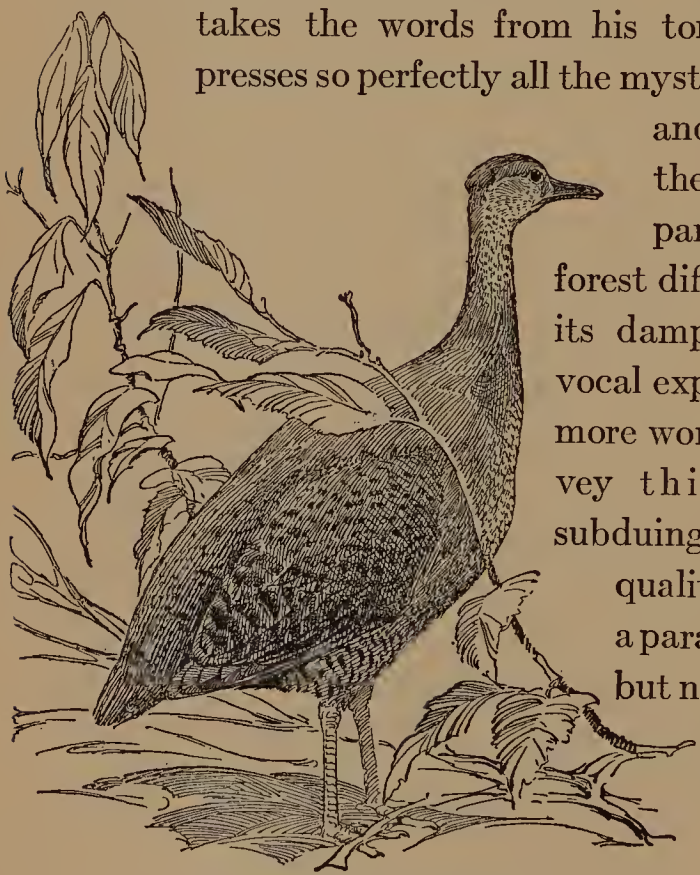
At the very beginning I find myself at odds with the systematist for I place at the head of my list birds that he puts at the foot of his. At once, also, I realize, as indeed I often have before, how im-

possible it is to put on paper a description of a bird's notes that will convey to others an adequate idea of their character and significance. The Tinamous, if one may judge by the effect of their calls on the sympathetic listener, are among the great songsters of the tropics, but nothing that I can write will give even a faint conception of the singular beauty and appealing quality of their notes.

In appearance and general habits, Tinamous resemble Partridges and the name Perdiz is applied to several species. They belong, however, to a family confined chiefly to the American Tropical and South Temperate Zones, and have no close relationship with the Partridge family of the northern parts of both hemispheres. Of the two species living on Barro Colorado, the smaller, or Pileated Tinamou, is somewhat larger than our Bob-White. It lives at the border of the forest and in bushy second growths. To be impressed by the voice of this bird one should be near enough to the singer to feel the pathos of its exquisitely pure, vibrant trilling as, uttered with an impassioned increase in rapidity, phrase after phrase rises in volume and then suddenly dies away. The bird may be at your very feet but always it remains invisible. It was of this bird that Louis Fuertes wrote:

"I think no sound I have ever heard has more

deeply reached into me and taken hold. Whether it is the intensity of feeling that a deep, silent forest always imposes; the velvet smoothness of the wailing call; the dramatic crescendo and diminuendo that exactly parallels its minor cadence up and down a small scale; something, perhaps the combination of all these, makes one feel as if he had been caught with his soul naked in his hands, when, in the midst of his subdued and chastened revery, this spirit-voice takes the words from his tongue and expresses so perfectly all the mystery, romance, and tragedy that the struggling, parasite-ridden forest diffuses through its damp shade. No vocal expression could more wonderfully convey this intangible, subduing, pervasive quality of silence; a paradox, perhaps, but not out of place with this bird of mystery." The Chestnut-headed



Chestnut-headed Tinamou

Tinamou, the larger of the two island species, is about the size of a Guinea Fowl. It lives within the forest where we often meet it on the trails. Its song is simpler in form than that of *Crypturus*. It consists of only two long-drawn, trilled measures which, after a short interval, are repeated, usually twice and rarely more than three times. So full and rich are the bird's tones, so flawless its execution, that merely as a musician it deserves high rank, but there is a quality in its fluted notes that moves one quite as deeply as does the thrilling crescendo of *Crypturus*. The latter is a bird of the early morning; *Tinamus* of the evening. Each sings, therefore, against a background of silence that makes its notes doubly impressive.

Few birds sing at night during the dry season on Barro Colorado. The Spectacled Owl utters its hesitating, whistled hoot in an immature and sometimes cracked voice. On the south side of the island, "Juan," doubtless another Owl, has the stage to himself and fills it!

In my visits prior to 1929 the voice of the Parauque was conspicuous at dawn and dusk in the clearing; but in the early part of that year it was wanting. A bird of open spaces and scattered growth, it was one of the pioneers in our clearing where there were apparently only two pairs—one near my house, the other on the slope beyond the landing. Its habit of

roosting as well as nesting on the ground makes it particularly susceptible to attack from terrestrial foes, and I attribute its disappearance to Coatis which in exceptional numbers frequent the clearing.

Later in the season the Parauque reappeared, doubtless coming from the mainland. Meanwhile the Goatsuckers were represented by Poor-me-One, possibly the most distinguished member of their ancient order. No bird could have been more welcome to me. I have deeper association with its notes than with those of any other tropical species. Thirty-seven years ago, on entering the forests of southern Trinidad, I had been told to listen for the song of the Two-toed Anteater, locally known as "Poor-me-One," meaning in negro dialect "poor me all alone." So clearly were its notes described and so well does this name express their singular quality that when, one moonlight night, I heard this voice in the forest I had no doubt of the identity of its author. The incident is described in my journal for March 27, 1893: "Five Glaucidiums (Pigmy Owls) were calling and there was the sudden scream of a Barn Owl. But best of all I heard the Anteater call. At first I thought it was a boy. It is a soft but loud, sad, flute-like note. I have never heard such a human sound from a brute before. It made the goose-flesh rise all over me."

Subsequently I acquired a living Anteater. Its

silence and repeated hearings of the strange voice in the forest convinced me that Poor-me-One was not a mammal. But I was unable to determine its identity and when, a month later, I sailed for home, I left this problem to Albert Carr, a keen local naturalist. He solved it; and the succeeding year when, with William Brewster, I went to Trinidad, under Carr's guidance we actually saw Poor-me-One calling. The experience is described in *The Auk* for 1895, pp. 201–211; and the colored plate illustrating our article was drawn by John Ridgway from the photograph (see plate facing p. 53), made at that time, of a slightly winged bird.

In a measure, then, it can be understood what it meant to me to hear Poor-me-One on Barro Colorado. But only in a very slight measure, for no one unfamiliar with the notes of this bird can realize the impression they create on the mind of one responsive to the voices of nature.

In form it is a very simple song of six full notes slowly descending the scale, each an interval apart. But notes of such richness of tone, so suggestive of sorrow, that in all the world of birds or man I have heard none sweeter or sadder. So strongly does this song express human emotion that one thinks of it as a woman's voice—a deep, mellow contralto calling in hopeless grief.

Waterton doubtless referred to this bird when he compared the voice of "the largest Goatsucker in Demarara" to "the last wailing of Niobe for her poor children."

"Donato," I said, when on the night of December 21, I heard Poor-me-One from the laboratory, "What is that calling?" "Perico ligero" (Three-toed Sloth), he replied. It was the Trinidad myth in different form. Miguel, from southwestern Colombia, independently gave the same answer, showing how widespread is the belief that the Sloth is the author of these notes.

When the bird evidently changed its position and called from different places, neither boy could explain how a Sloth could move so rapidly, and while both professed to accept my identification I believe that they still adhere to their own. It is the only time I have known Donato to be in the wrong.

From the date named until March 3, Poor-me-One was heard calling almost nightly. Usually it sang between 8 and 11 o'clock and again in the morning until 6 o'clock, but on and near the periods of full moon it sang throughout the night. At 3 o'clock on the morning of February 25, I heard Poor-me-One and both the Pileated and Crested Tinamous. What a trio! and with the moon what a quartette! It swept a strong hand across one's heart-strings.

Lest I convey the impression that the songs of all Barro Colorado birds are of the highly emotional character of the three already mentioned, without sacrifice in our musical standards I may now introduce the Wrens. I have already spoken of several of the Wrens of the arid tropics, with which the House Wren of our clearing may be included. Of those that remain, the Wood Wren alone is common and shall be mentioned first. If the merits of a bird's song should be judged by the small size of the singer, then the Wood Wren is one of the most notable songsters, not only of the American tropics but of the western hemisphere. It is a true humid forest bird, living in the Subtropical, as well as the Tropical Zone and ranging from Mexico to Bolivia and the Guianas. Its size is smaller than that of a House Wren and, doubtless in response to the greater dampness of its haunts, it is of a deeper and richer brown. The sides of its head are black striped with white, and a conspicuous white line over the eye adds to the distinctiveness of its markings. Living in the denser lower

Wood Wren

growth and tangles of fallen tree-tops it is not seen without an effort; but no effort is required to hear it!

If the Wood Wren were a human musician he would be classed as a brilliant performer with a highly developed technique and a large and varied repertoire. As a bird he surprises us by the volume of his song and by the abrupt changes in its key and character. One looks for a bird four times his size.

An entry in my journal for December 29, 1926, following a description of the song of Lawrence's Wren, reads: "Nearby a Wood Wren, not to be outdone, gave a display of his vocal versatility. Several loud musical phrases may be written, *Alas poor Yorick; William, William, Willow;* and in another key, *cheero-cheero-cheero*, interspersed with a thin, sibilant *spee-spee* etc., and a metallic *ter-leek.*" The bird is an animated, spirited singer; its enthusiasm is contagious; I always applaud it.

Inhabiting the same dark places as the Wood Wren is another member of this musically gifted family with which I have long desired closer acquaintance.

Lawrence's Wren, the Panama representative of this group, possesses the deep colors of the true forest Wrens, but in place of the white markings of the Wood Wren it has the sides of the head and throat bright chestnut. A large bill with an elevated culmen or ridge is a singular character of the group.

A few days after I had first entered the mountain forests of western Colombia I was thrilled by a long-drawn, double-toned, vibrant whistle, so unlike any bird-note I had ever heard before, so loud and air-filling, that I had no conception of the bird's whereabouts either in classification or space. With eyes on the trees overhead I attempted to imitate it, and in a moment a Ridged-bill Wren[1] appeared at my feet.

I did not meet with a Wren of this group again for fifteen years, when, on Barro Colorado, on the morning of December 26, 1926, I was startled by a whistle so human in tone and type that for some moments I was undecided whether man or bird was the author. My journal reads: "From near the entrance to the Shannon Trail there came from the forest, at least one hundred yards away, two full-throated whistles, so loud, so clear, so perfectly spaced that I thought at first someone was calling. But the notes were too vibrant, too wild, too musical, too expressive to be from human lips. They were wood-notes. I was hearing the voice of a notable bird personality. This impression I got from just two notes but, as I listened, the second note rose a perfect half and at the same time I heard a singular *churring* sound, though the two seemed wholly un-

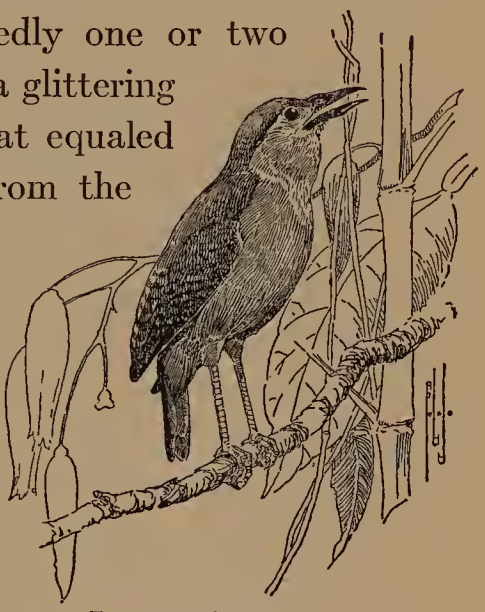
[1] *Leucolepis dichrous.*

related. I tried to answer the whistle; at least I could get the form. Almost at once the strange notes sounded nearer, and within two minutes the birds were within twenty feet of me. Again the notes changed but always the interval conformed to that of our scale. I could see plainly now that it was Lawrence's Wren. In singing, the bird seemed to stand on tip-toe, with neck stretched up to the utmost, like that of a crowing cock. The loud, growling *chur* formed a background to the whistle and always accompanied it. Perhaps this was the voice of the female."

Two days later I heard the species again. On this occasion he added to the long-drawn couplets a phrase of four notes of the same rich, vibrant quality. There was no suggestion of the yodeling of our Carolina Wren and some of its allies. The following day, while one bird, probably the female, uttered continuously a chuckling *cútta*, *cútta*, *cútta*, the male sang a winding whistle of seven or eight notes, the first low and throaty but full-toned and musical, with a vibrant, harp-like quality and rising to a clear, sweet pipe. Since that day *Leucolepis* has often greeted me on the trail with its *cútta-cútta*, but its song I have not heard again. The rains continued that year into January. Possibly this Wren nests in the wet season and was induced to prolong its song-

period by unusual weather conditions. If this be true, it is probable that I am familiar with only part of its repertoire.

The Bay Wren I have met but once, when, fortunately, he sang repeatedly one or two measures of his song with a glittering brilliancy of technique that equaled anything I have heard from the Nightingale. It resembled, indeed, one of those passages in the Nightingale's song which seems impossible of execution but which the bird delivers with an ease and perfection that commands a tribute of astonishment and admiration such as we pay to no other bird.

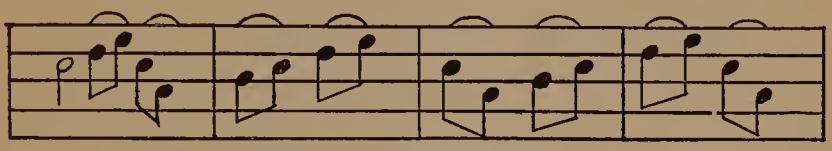


Lawrence's Wren

No experience I have had on Barro Colorado in tracing a song to its source has been more surprising than my discovery of the song of the Dusky-tailed Ant-Tanager. Tanagers, as a rule, are possessed of but little talent for music. The Scarlet Tanager and Summer Tanager, the two species that reach eastern North America, are unusually gifted members of their family. The notes of the common tropical species of the genera *Thraupis* and *Ramphocelus* are un-

musical, rather metallic twitterings scarcely deserving the name of song. Some of the pretty little Euphonias have pleasing voices, and there may be others, like the Ant-Tanager, who have sung only to their mates. Certainly the Ant-Tanager did not enter the list of possibilities when, on March 25, 1928, on a trail which I had passed almost daily for four seasons, I heard a song so unlike any known to me that it immediately entered a class of its own. It was composed of sixteen highly musical, flute-like notes so exactly separated by the intervals of our scale that, judged even by human standards, they formed a true song. On three successive days rain had fallen. The wet season was apparently approaching at an exceptionally early date. There were new insect voices in the air, and I assumed that my unknown vocalist was a wet-season nester, perhaps Lawrence's Wren, just coming into song; but I was unable to find him. Only an Ant-Tanager scolded harshly when I pushed my way through the undergrowth.

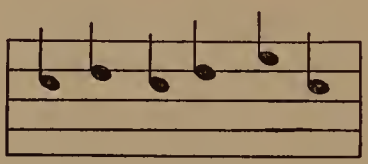
The next day I resumed the search, and with as keen interest as though I had been looking for a new bird instead of a new song. Reaching the bird's haunts I was met only by silence. But the song had sufficient character and melody to be memorized. I whistled it crudely and was at once answered from

a distance of less than twenty yards. All the excitement of the chase was mine. This time the singer should not escape. With a Wren in my mind's eye I watched the lower growth closely and discovered the song proceeding from the bill of an Ant-Tanager ten feet above me! If a lizard had been its author I could not have been much more surprised. Mentally I retracted many unpleasant things I have said and

The Song of the Ant-Tanager
Transcribed by Mrs. Jesse Metcalf

written about the character of the Ant-Tanager as I imagined it to be expressed by his "scolding" notes. I remembered, also, that the calls of Wrens are none too sweet. Then I wondered whether *Phœnicothraupis* has acquired a song as compensation for the possible loss of bright colors since he left the ranks of his brightly colored relatives of the tree-tops and open spaces and descended to the lower growth. At any rate he deserves a place in the first rank of tropical song-birds.

To the Panama House Wren may be added the Panama Blue Grosbeak as a tropical representative of a North American species. Unfortunately, I am

not familiar with the song of our Blue Grosbeak and cannot, therefore, make a comparison of its notes with those of the southern bird. As a vocalist, the Panama bird might be described as bilingual, for its song is composed of two parts as different from each other as two languages. One must, indeed, see the singer before he can convince himself that both are uttered by the same bird. This. however, is no easy task. The bird is common and sings frequently, but he is rather shy and so rarely does he leave the densest lower growth that it takes careful stalking and close watching to discover him. The first part of his song is a sweet, somewhat dreamy but clearly enunciated phrase of six notes with intervals that can be placed on our scale, as follows:



The Blue Grosbeak's Song
Transcribed by Mrs. Chapman

Without pause these notes are followed by a little twittering warble in another key and tone. The effect is as unusual and musically as incongruous as though a White-throated Sparrow should end his own song with that of a Junco. On two occasions in early January I have heard what appears to be the

"ecstacy" song of this species; a rapid, rushing melody suggesting the flight-song of the Rose-breasted Grosbeak both in form and tone. It was apparently given from a perch, lasted for about three seconds, and was closed with the usual song.

In the same family, but belonging to a different genus, is the Slate-colored Grosbeak, a bird about the size of a Cardinal and like it with a red bill. While the Blue Grosbeak lives in the lower growth, this species frequents the tree-tops where it is even more difficult to see. Although it is certainly one of the most common song-birds on Barro Colorado, and is heard from the forest about the clearing throughout the greater part of every day, I do not see it more than once or twice each season. It has five songs, each composed of five or six musical, high-pitched, clearly whistled notes. They differ in form but agree in general character and quality of tone. *I go to Guayaqù-i-l* he calls, with the last note prolonged and elevated; then adds, quite irrelevantly, *Pretty Chillibreeyo* or *Cre-a-tór, cre-a-tór-ee* and so continues cheerfully to address his kind apparently in no way depressed by the fact that, as a songster, man seems unaware of his existence.

It is difficult to know just what place to accord Lawrence's Cacique in our list of Barro Colorado's song-birds. In his own field he is unquestionably a

master, and if we add that his type of bird-song bears the same relation to the pure, chaste notes of the Tinamous that jazz does to Bach or Beethoven, we will accord him full credit. That he has ability no one will deny, but to my mind he is a self-conscious, musical poseur more intent on exhibiting himself and his technique than in giving expression to genuine emotion. There is infinite variety in his high-pitched notes and liquid, gurgling phrases. He often begins "I've come to see you off; I've come to sée you," then, separated by short pauses, there follows a surprising series of calls long and short, all executed faultlessly. One phrase bears a strong resemblance to a part of the Western Meadowlark's song but it is lacking in the quality of sincerity which makes the song of that bird so dear to us.

I should enjoy the performance of the Cacique more if there were an obvious reason for it, and if he were somewhat less voluble. I resent his assumption that, when in a colony of Oropéndolas, the center of the stage belongs to him. It is true that the female Oropéndolas seem deaf to him, and I often wonder what heights he must reach when addressing susceptible females of his own species.

The Oropéndola is a musician of the Cacique's school with much to learn before he can enter the Cacique's class; but if earnestness and persistence

count for anything, he will advance. Meanwhile it is not necessary to repeat here the description of his notes given in the study of his home-life.

Finally, I think that the Wood Quail should be added to our list of forest songsters. They are beautiful birds about the size of our Bob-White, somewhat the same color above but uniformly brownish below. They are confined to the forest where, even when they are common, one rarely sees them. Their song is so unlike any note we associate with Quail that it does not even suggest the voice of a gallinaceous bird. Apparently two birds, perhaps a pair, sing together.[1] They are usually heard in the evening or just after nightfall when the prevailing silence adds greatly to the impressiveness of their notes. These are very loud, quite musical, and uttered so rapidly that often the birds pause through obvious inability to articulate with sufficient rapidity to maintain an increasing tempo. *Corcorovado, corcorovado, corcorovado,* they seem to say, with a rolling, warbling delivery and an excited manner which always impels one hearing it for the first time to ask eagerly "What's that?" This performance is some-

[1] Since this was written I have seen two birds, presumably male and female, in Mrs. Bryan's aviary, at Ancon, face each other at a distance of a foot or two and sing a duet in perfect unison. As one called *Corcoro* the other added *Vado.* The syllables were uttered rapidly, the timing was perfect, and the performance clearly revealed the method by which the song of this species is produced. It also showed what may be learned from birds in confinement under proper conditions. There is an as yet untouched field for this kind of research on Barro Colorado.

times continued without a break for nearly two minutes. The birds must inhale while singing but their notes give no evidence of it, though toward the end they seem to get somewhat out of breath and slacken their pace.

Wood Quail

With the Wood Quail I should end my list of notable forest songsters of Barro Colorado. It is significant that of the thirteen species included, nine belong in the Order Oscines, or true songbirds of the systematist and anatomist, while four have won a place, though without the more highly-developed vocal apparatus of the Oscines.

I have spoken of the part played in the morning chorus or in the notes heard from the trail and clearing, of Doves and Pigeons, the Guan, Wood Rail, Parrots, Motmots, Trogons, and Toucans, and to complete this sketch of the bird-voices of a tropical forest I may add a word or two concerning the notes

of several other groups of birds not included in the list of leading songsters.

The Antbirds and Woodcreepers, both in the number of species and variety of their calls, contribute largely to the volume of forest bird-notes, though none can claim distinction as a singer. The rail-like outcry of the White-bellied Antbird, the rather plaintive whistles of Sclater's Antbird and the Panama Antthrush, the soothing little chants of the Fasciated Antshrike, the varied calls of Lawrence's Antpitta, and the whistles of Woodcreepers, fill distinctive if minor parts in the forest orchestra.

The chatter of the larger Flycatchers of the clearing is one of the characteristic sounds of a tropical day, but the forest-inhabiting species have, as a rule, insignificant voices.

The Manakins are instrumentalists rather than vocalists, but their relatives, the Cotingas, vary as much in voice as they do in size. At one extreme are the Bellbirds of Guiana and Brazil with their far-carrying, explosive, metallic notes, at the other, the nearly voiceless Tityras. A pair of these pearl-gray, black-headed birds, as large as a Robin, tries each year to find a nesting-hole in the upper branches of a dead tree near the clearing whence their low, husky *cack* is barely audible. I have heard a somewhat similar note from the female of Natterer's Cotinga.

The *beat-it, beat-it, beat-it no-ó-w* of Sclater's Attila is a well-marked forest note, and the sharp, commanding whistle of the large Panama Lathria halts you in your tracks.

The Purple-throated Fruit Crows are among the most common and willing performers of this family. They are thick-set birds with large heads, in color shining black, the male with a maroon throat which, in life, is visible only from certain angles. They are usually in small companies of six to eight birds, that seem constantly on the move from one fruit-bearing tree to another, calling as they go. Heard in the distance, their loud *cher-káw, cherk-ków,* often repeated and on changing keys, even by the same bird, is strongly reminiscent of the latter part of the phrase with which a hen proudly announces the deposition of an egg. A long-drawn, upward sliding *coo* follows, and at shorter range one hears a note strongly like the throat-clearing scrape that precedes expectoration.

As they alight they lower their head and shiver their tail violently from side to side as though they were shaking something out of it; then dart out at some berry or small fruit, which they take on the wing, and in a minute or two are off to some other feeding-place. An altogether unusual character is the Fruit Crow. The woods seem comparatively

silent and deserted after he and his care-free band have passed.

Singularly enough, the large yellow and green Vireos of the genus *Cyclarhis*, so widely distributed in tropical America, have never been found in the Canal Zone, and in the forest the Vireos are represented by the Panama Shrike-Vireo. As though impressed by the responsibility of acting as spokesman for his family, this bird repeats his "one-two-three," all on the same note, with a tireless persistence that even our Red-eyed Vireo might envy. I often wish there were some way of assuring *Vireolanius* that he is doing more than his duty.

The Wood Warblers, beloved by northern bird-students, are almost unknown, vocally, in a tropical forest. All but Sclater's Warbler, one of the species found on Barro Colorado, are winter visitants from the north, and in the whole Canal Zone only the Buff-rumped Warbler, among resident species, is accredited with a notable song. This is described by Jewell as "a beautiful, clear and ringing song somewhat like the Ovenbird's but more striking because the crescendo rises higher."

The Honeycreepers are common but their claims to distinction must rest on their bright colors, for their notes are insignificant.

The Crows and Jays are members of a northern

family with but few representatives in the far south. No Crows and but few Jays are found in the tropics south of Mexico. The large Talamanca Jay is the species of Barro Colorado. It travels in small groups

Talamanca Jay

and, when encountered, makes its presence known in many and no uncertain tones. But in spite of its restless, wandering habits, large size, and loud voice, I rarely meet this bird more than once in a season.

With this Jay our review of the more important bird vocalists of Barro Colorado is completed. To sum up, while it is true that the voices of songless birds supply the greater part of the volume of sound in a tropical forest, there are also musical if less vociferous species whose names are wholly worthy of being inscribed with those of the world's great songsters; and when to the list of forest singers we add the names of those that inhabit the more open spaces, we have a band of feathered vocalists who could hold their own in competition with those of any other part of the world.

CHAPTER XI

THE MONKEYS

ONE need not be a professed mammalogist to yield to the singular fascination exerted by a band of Monkeys in its native haunts. When, therefore, these indigenes appear near the laboratory the botanist deserts his plants, the entomologist his insects, the ornithologist his birds, all impelled by a community of interest which expresses the validity of a zoölogical classification founded on real affinities and, in a measure, demonstrates the truth of the dictum that the proper study of mankind is man.

The Monkeys return the compliment. Quite obviously we arouse in them an intense curiosity. Whether this is because we are new and unusual, or whether, in spite of our bipedal, terrestrial habits they are impressed by a relationship all too evident to us, who can say? But there is something in the Howler's steady, intent stare, in the efforts of the Capuchin to obtain a nearer and a better view, in the Night Monkey's peering, and the Marmoset's awareness that warrants the belief we are something more to them than merely large, strange creatures.

THE NIGHT MONKEY
(*Aotus zonalis*)

My experience with the Night Monkey is limited to seeing their little, gnome-like faces looking eagerly down at me from the doorway of their home in a hollow tree and to a glimpse of their small, active bodies against the sky at dusk or in the rays of my searchlight after dark. I have seen them spring across an opening a yard or more in width and a hundred feet above the ground, to hurry off through the tree-tops, evidently certain of their footing. They must see by night as clearly as diurnal animals do by day. No half vision would carry them safely over the roads they travel.

Three of these little creatures live somewhere in a large, parasite-covered tree at the border of our clearing. Some evenings I hear their low *put, put* and see them start for a fig tree that nearly overhangs my house. Their day apparently lasts all night for they do not come home until morning. Doubtless because they have such quaint little faces, I always think of them with a smile.

THE SQUIRREL MONKEY
(*Leontecebus geoffroyi*)

Seen in the forest the Squirrel Monkeys, Marmosets or Titis, as they are also called, are most attrac-

tive. Their white underparts, snowy crest, and chestnut nape are unusual and pleasing. They are active and agile, and their evident curiosity concerning us arouses a corresponding interest in them. But they are rather shy, constantly on the move, and cover so wide a territory that I have learned nothing of their family life. They travel in companies of from three or four to a dozen or more, usually at mid-forest altitudes and sometimes through the lower growth. Occasionally a band passes within thirty-five feet of my window. They are better gymnasts and lighter on their feet than Squirrels. The latter pause after a spring to consolidate, as it were, and make sure of their footing before resuming their journey, but the Titi can move continuously and rapidly. Where a Squirrel crashes along, the Monkey makes comparatively little noise.

Indeed, one often is first apprised of the Titis' presence by their calls. Even then, so high and piping are their voices, he will think that birds rather than mammals are their authors. Their calls are varied, are frequently uttered, and doubtless serve to keep the members of a flock together as they travel rapidly through the forest.

The Titis have well-developed but not prehensile tails which, unless they serve as balancing-rods, appear to be of no service to them when under way.

Seen at close range, in captivity, the Titi loses much of his attractiveness. His small face and miniature features remind one of the dried human heads prepared by the Jibaro Indians of eastern Ecuador. Two that we have in captivity at the laboratory are selfish little creatures with neither love of play nor sense of humor. Claudia, a baby Howler, won my affection but the Titis make no appeal to me. Their dispositions are clearly revealed by the expression of their hard little faces.

THE CAPUCHIN OR WHITE-FACED MONKEY
(*Cebus capucinus imitator*)

Here is a master of his environment. Not even a bird passes through the forest with greater freedom than this quadruped. He skips and dances along the limbs and, without pausing a second to measure the distance or select a take-off or a landing-place, recklessly hurls himself through space and, with arms and legs widespread, crosses openings at least ten to twelve feet wide. Involuntarily I shout my applause; but with him it's all in the day's walk. He is doubtless unaware that he has done anything unusual. But his progress is not so heedless as it seems. He evidently takes note of things as he passes. One, hurrying through the tree-tops, stopped, went back a few yards over his route, and with some little effort

broke off a decayed limb and threw it to the ground. Whether it had annoyed him or whether he considered it unsafe for future passage I do not know. When traveling, the tail is rarely used as a prehensile organ but is curled up inwardly. In this respect the Capuchin differs markedly from the Howler. Nor do all the members of a band follow the same route through the tree-tops; their objective may be the same but they go different ways to reach it. Even those that use essentially the same path vary its details and are far from following in each other's footsteps. All of which illustrates the Capuchin's freedom of action.

The Capuchin's white face, and particularly his beard, emphasize the humanlike qualities of his physiognomy. An old male with a throat-ruff suggests a Hibernian philosopher of the Mr. Dooley type. One longs for a closer acquaintance with him, but, unfortunately, he lacks faith in our good-will. Although his expression bespeaks a far more cheerful, friendly disposition than that of the Howler, the latter shows far less fear of man. Nevertheless, the Howler dies, and the Capuchin thrives in captivity.

While our appearance frightens the Capuchin it also fascinates him. When flying through the tree-tops from us, at intervals he pauses, and even returns a few steps for another look. The distance at which

we continue to attract him, and especially the conditions under which he can distinguish us, are surprising. Watching one through a glass, when he was eighty yards or more away, and from what I fancied was concealment, I have seen his eyes still fixed upon me.

The Capuchin, indeed, is far more responsive to us than is the Howler. He will go out of his way for a better view. I recall one that visited a low tree about one hundred feet from the laboratory, apparently attracted by us as we sat at dinner. He went from one branch to another, peering keenly, and from time to time gave expression to his curiosity with a questioning *chung!*

In their family life, Howlers are phlegmatic and peaceful but Capuchins are excitable and aggressive. On occasions, unrestricted warfare seems to prevail, and with squeals and screams every member of the band is either in pursuit or retreat. They perform incredible feats of agility and fly through the tree-tops so rapidly that I have never discovered the cause of the disturbance. Apparently it is tribal rather than individual, for suddenly there is absolute silence, the fight is off, and the animals disappear.

The group-organization of Capuchins is much looser than that of Howlers. I should speak of a clan of the latter and a band of the former. The members

of a Howler clan are rarely separated by more than a tree or two, but a band of Capuchins may be scattered through the forest for a quarter of a mile or more. I have known the laboratory to be surrounded by a band of Capuchins distributed from the trees above the dock to those on the opposite ridge. There were about fifteen of them, a large band.

Capuchins keep in touch with one another by uttering, at short intervals, a hoarse, raucous, scraping squawk. This location-call is repeated by one animal after another in orderly succession, as watchmen relay their signals, and it at once reveals their positions. Fragments, so to speak, of this same call are used in a conversational way and an emphatic *chung!* expresses their feelings when we meet in the forest. At times this call sounds like a questioning *how?*

While Capuchins prefer first-growth forest, they are not restricted to it. One meets them, therefore, at places on the island where Howlers are unknown. There is, consequently, a wider area available for their occupation, but they are so much less sedentary than the Howler that a band doubtless requires a larger territory than that occupied by a clan of Howlers. I can offer no estimate of the number of Capuchins on Barro Colorado; nor can I say whether or not they outnumber the Howlers.

Capuchins eat insects, birds' eggs (doubtless also young birds), and fruit. As a rule, they are very wasteful, mutilating far more food than they eat. They test fruit still on the limb or pluck it, take a bite or two, and let it fall to reach for another. But a member of a band that passed my house late one evening had a large, round, green, nut-like object with which he evidently did not want to part. Stopping on a broad limb, he tried unsuccessfully to open it with his teeth, then took it in both hands and, with much force, brought it down on the limb; *thump*, *thump*, *thump*, *thump*, four times he pounded without result then, with the nut grasped in one hand, he followed his companions. Three more times, at increasing distances, I heard the four thumps as, undiscouraged, he continued his efforts to crack his prize.

Food is so abundant that I doubt if it plays an important part in determining the numbers of these animals. It is rather the extent of the area required by clan or band in which it can live without conflicting with others of its kind. But between the Howlers and Capuchins there is apparently no question of territorial rights. On several occasions I have seen individuals of both species feeding in one tree.

Their fear of man, activity, roving habits, and lack

of close group-association make the Capuchin more difficult to study than the Howler. Only twice have I had a glimpse of its more intimate family life. On the evening of February 27, 1928, a band of Capuchins was feeding in the forest east of the laboratory. Several of them entered a tall, widely branched tree growing near our dock. Distant from us about 200 yards, they were wholly unaware of our presence, but with the aid of a 24-power binocular their movements could be closely followed. Their hunger satisfied, the younger members of the group were evidently out for a frolic before retiring. They scampered from limb to limb, jumped over each other, and pulled each other's tails; while an old male stretched himself in a wide-spreading crotch and two smaller adults ministered to his comforts. They scratched his head and scratched his tail, lifting the latter in both hands to examine it more closely; at times they bit it, perhaps thereby removing a tick, while he, reclining, accepted these attentions as his due.

On the evening of the following December 31, a band of Capuchins was about the laboratory. As before, an old male occupied the crotch in the big tree above the pier. He was attended by three smaller ones. It was rather late when I discovered them and I could not clearly determine their rela-

tions, but it was evident that he was the object of their affections. The sky still showed blue through the branches, the lake was below them, a profusion of vegetation about them, and in the peaceful beauty of their surroundings and complete unconsciousness of being observed they filled one's ideal of a perfect picture of tropical wild life. Imagine now, this petted old sultan sold into bondage, wearing a little red jacket and trousers and, at the end of an organ-grinder's chain, passing his cap for pennies. Could a wild animal suffer greater degradation?

THE HOWLER
(*Alouatta palliata inconsonans*)

A Howling Monkey in the tree-tops, defying by voice and gesture a passing airplane, would make a fitting emblem for Barro Colorado, and at the same time symbolize the inevitable domination of man. While by no means the most common, its habits, and particularly its voice, make this species the best known of our island mammals. On a still morning, under favorable conditions, a band of Howlers may be heard at least two miles. Their emotions call for frequent vocal expression and one cannot, therefore, live long in the haunts of Howlers without becoming aware of their presence.

The call to which the Howler owes its name is less

a howl than a bark. Beginning as a low grunt, it grows louder, more rapid, more incisive, and quickly rises to an overpowering, ferocious-sounding roar. A single Howler might challenge a Lion to a vocal duel with every hope of victory; when a band of Howlers join voices the Lion may well retire from the field.

A Howler chorus is one of the most impressive sounds in the animal world. When you are its cause, and a bearded old male Howler with the face of a satyr climbs down threateningly toward you, every tooth revealed as he roars, it requires some self-persuasion to hold your ground. If Howlers were terrestrial, an imaginative person would not enter their haunts unarmed.

Why do the Howlers howl? This question may be answered, at least in part, by stating *when* Howlers howl. It should be noted, in the first place, that the call is not restricted to the male. He is the leader and his voice is the loudest. Often he alone roars, but in a true Howler chorus the females and young call with the male. It is with this chorus that the Howlers greet the coming day. At that time it seems primarily inspired by increasing light and is, perhaps, an expression of physical well-being after a period of rest. Doubtless, once started, the singers may respond to the voices of other Howler clans. At this hour the

howl may possibly be considered as a song, though the fact that the females and young are vocal seems to deprive the performance of sexual significance.

How do the Howlers howl? With the aid of what, in effect, is a "loud speaker" described by Mivart as "an enormous distension of the body of the hyoid

The Howling Monkeys' "Loud Speaker"
The bony cup of the hyoid bone shown enlarged at the right is figured in position between the jaws at the left

bone into a large, deep bony cup, sheltered between the two jaws which are especially deep for that purpose. Into this cup is received one of the three or five sacs with which the larynx is provided." Thus, doubtless as one produces a resounding note by blowing across the mouth of a bottle, the Howler creates the great volume of sound to which he owes his name.

Of the inter-relation of Howler clans I know nothing for I have never seen two clans associated.

I have, however, heard three clans calling at the same time and they seemed to be mutually stimulating. In view of the small number of individuals composing a clan it may be imagined that there is intermating between the clans. Hence, at times, the calls exchanged by members of different clans may have some special meaning.

Almost invariably the Howler, like a simian Ajax, roars defiance at a heavy storm, but whether it is a leaky roof or the sound of falling rain that arouses him, I do not know. Claudia, a captive Howler, whose history is given beyond, cried piteously when we attempted to give her a shower bath. On the other hand, the near approach of an unseen airplane always induced her to roar; and nothing is surer to produce a response from a Howler clan than the sound of a nearby airplane.

The presence of man often prompts Howlers to call; indeed, one may first become aware of their proximity by hearing their low grunts from the treetops. If one passes onward nothing more is said, but if one stops, the grunts may become louder and quickly rise to a roar. If there is no such demonstration, it may be produced by shouting, or clapping one's hands. It is clear, then, that the Howler's roar gives expression to widely varying emotions, even if we cannot accurately classify them.

When in the tree-tops, Howlers show no fear of man. They are wholly aware of our presence and watch us intently, and may roar at us, but their distance above us evidently induces a belief in their safety. While, therefore, one may observe them for hours from below, he cannot approach them closely, and without the aid of a glass I have never had a thoroughly satisfactory view of an adult Howler's countenance. Even when, while roaring, he comes down the tree toward me, he does not get near enough to reveal in detail the outlines of his features and the significance of his expression. Furthermore, at such times one's powers of perception and analysis seem submerged by sound and all one's reactions function through his ears. Thanks, however, to a 24-power binocular, mounted on a tripod stretched over a swinging-back chair in which, recumbent, I may gaze comfortably and continuously at the zenith, I have devoted many minutes to gazing at the physiognomy of an old male Howler. I have seen him roar and I have seen him yawn, I have seen him awake and also asleep, and the sum total of my impression is that his face is the incarnation of every evil thought that has ever passed through the mind of man. Large, round, sooty black eyes, deep-set, far apart, and overhung by a low forehead, nose so flat that it is little more than a site for the nostrils, mouth so enormous

that when widely opened the head disappears behind gaping rows of teeth, a scraggly beard, the whole expression an inconceivable exaggeration of gloomy, bestial brutality.

Doubtless, however, the Howler is more or less libeled by his appearance, and I should add at once that so far as my observations go his family life is a model for Monkeys. Nevertheless (though this may be to his credit), the fact that he is absolutely untamable and, when captured, an adult does not long survive confinement, indicates that to some extent his expression reveals, if not the savageness, at least the strength of his character.

The adult femalcs are less repulsive. Indeed, I recall one placidly nursing her baby in the tree-tops who, if she had been human, would have been called a fine-looking woman. The young, when in good health, are singularly attractive. Caged Monkeys have always repelled me, but I confess without reserve that I yielded wholly to the winning personality of a young Howler whose all too short life was passed as the welcome, if unwilling, guest of the laboratory. An adult male measures about four feet from the crown of his head to the end of his tail. One-half of this is tail, a Howler's most important limb. The Howlers of Colombia are rich ferruginous; those of Central America black; but the bright rusty

color on the sides of most Barro Colorado Howlers indicates their close relationship. Adult females resemble the male in color, but very young Howlers are distinctly yellowish.

The ease with which Howlers may be seen and heard, and their comparatively sedentary habits, should make it possible for us to determine with some exactness the number of these animals living on the island. They are distinctly inhabitants of the forest primeval, and frequent not only high trees but their upper branches. Only under exceptional circumstances have I seen a Howler near the ground. Second growth they avoid. About one-half of the island, therefore, is suited to their requirements.

During the winter of 1928–29 I estimated that this area was occupied by seven clans of Howlers. I base this estimate on my own experiences, and also on those of our resident guide, Donato, whose powers of observation and conservatism in statement make him an exceptionally credible witness. As a matter of record, and for the benefit of future students, I list these clans under name of the locality which is believed to be near the center of their range, as follows:

(1) Laboratory
(2) Pearson Trail, near 18
(3) Zetek Trail, near 16

(4) Armour Trail, near 10
(5) Drayton Trail, near 15
(6) Wheeler Trail, near 24
(7) Van Tyne Trail, near 9

I am by no means certain of the correctness of this statement, but in my opinion it is conservative. Possibly there is an additional clan between the ends of the Armour and Drayton Trails. We do not know definitely the exact range of any of these clans, with the possible exception of the one living near the laboratory. That appears to be confined to a district bounded approximately by the clearing, Snyder-Molino, Pearson, and Wheeler Trails.

Allowing an average of ten individuals to each clan, and on the basis of the estimate here given, our present Howler population is approximately seventy individuals. These clans or bands are usually composed of two adult males, and a young male or two, while the remainder are females of whom one or two have young in arms.

The presence of only two adult males indicates that Howlers are not monogamous, but whether they are polygamous or promiscuous, whether the male recognizes his own offspring as such and assumes any responsibility in its upbringing, are questions my observations do not definitely answer.

There appears to be no regular season for the birth

of the young. A baby captured near the laboratory in October, 1928, was approximately two months old, and I have seen others less than a month old in the latter part of December, in early February, and late March.

The single young is carried by its mother on her breast, abdomen, or rump, the first-named position being chosen by very little ones, the last-named by larger ones. Even when comparatively well-grown their presence does not appear to discommode her as she climbs from limb to limb when feeding; but when, in traveling, she is forced to spring for a branch she uses more care and exerts more effort than individuals not handicapped by the weight of offspring. While they spring at the first intent, she makes several preliminary motions to help gather momentum before "taking off." The young evidently remain with their mother as long as she will care for them. I have seen suckling young half the size of their parent.

Life within the clan appears to be wholly peaceful. Neither by word nor deed have I observed any evidence of anger or selfishness. When resting or feeding, a single tree usually holds all the members of a clan. If, when passing from place to place, an individual finds another asleep or resting in his road, he passes over or around him without dissent. No

manifestations of courtship have been witnessed, and I cannot say, therefore, to what extent sexual jealousy might develop under the stress of competition. The absence of such competition would indicate definite pairing and the recognition of mating rights.

Howlers, notwithstanding the apparent ferocity of their calls and their appearance, feed largely, indeed, so far as my experience goes, wholly on vegetation, chiefly leaves. They have an obvious preference for certain kinds, and, in the vicinity of my house, select both the fruit and leaves of a wild fig, and the buds and leaves of an acacia-like tree, as I have before said. While it is true there is an abundance of this food, I have never seen one Howler interfere with another while feeding.

A clan may visit only a part of its territory daily, but when traveling from one point to another, definite highways appear to be regularly followed. Certain limbs are used to reach certain other limbs and, when undisturbed, each Monkey follows more or less closely in the wake of its predecessor. Their unmarked, leafy pathways seem perfectly clear to them, and even after nightfall I have heard a clan traveling overhead en route to their dormitory. Their course was marked only by the noise of the swaying branches as they swung or leaped from limb to limb.

They moved without apparent hesitation, evidence that they could see in what, to my eyes, was darkness. It is exceptional, however, for them to travel after dark, and, on the occasion just referred to, the clan had stayed beyond the usual bed hour to feed on the fruit of a tree about one hundred yards from their sleeping quarters. As a rule, they retire before dark and are awake by daybreak.

The extent of the daily range is determined chiefly by the question of food, and when some favorite bud, leaf, or fruit is available, the clan remains in the vicinity until the supply is consumed or they tire of it.

While the clan has no permanent home and its members make neither bed nor nest, they seem, when resident in one locality, to return to the same tree nightly to sleep. This tree is apparently selected with regard to its leafiness and the size of its branches. Such trees, indeed, make artificial shelter unnecessary. Their dense foliage forms a roof and their broad, horizontal limbs or widely branched crotches give safe and comfortable sleeping-quarters. On one they lie down; in the other, coil up; but always they guard against falling in their sleep by wrapping the tip of the tail around some vantage-point.

Although some Howlers live in regions with an annual rainfall that may exceed 300 inches, they have

not yet learned to endure a heavy shower without complaint. By night as well as by day they voice their resentment of the downpour, possibly in response to the noise of the deluge rather than to the discomfort of a leaky roof.

Compared with Capuchins, Howlers are cautious climbers. They make, it is true, apparently impossible journeys through the tree-tops, but their progress lacks the dash and recklessness of the Capuchin. This is no doubt due to their larger size and heavier weight, but it is also occasioned by temperament. A Howler is a sedate, dignified animal and his movements, for a Monkey, are rather slow. He never seems to be in a hurry. Unlike the Capuchin, he takes no chances. If the route appears to be too risky, he stops, looks the situation over, makes a test or two, and if they are unsatisfactory he seeks another way.

Deprived of his tail, a Howler would doubtless become terrestrial. This remarkable member is never idle. As we have seen, it functions when its owner sleeps, and he makes demands upon it every minute while awake. His confidence in its powers is limitless. It protects him from the danger of missteps or broken branches, it helps him safely over wide spaces; it is an anchor and a bridge in one. With it grasping a limb, he reaches fearlessly outward for

bud or fruit. Swinging pendulum-like, attached only by its tip, he scratches himself comfortably and even roars. When traveling, he drops from the end of one limb toward another far below, apparently realizing that while attached by his tail above, the weight of his body will bring him within grasping distance of the branch below. If it does not, and the space between is too great to risk a jump, he climbs up his tail and seeks another route. Even in death his tail is faithful, and many a Monkey-hunter has seen the animal he has killed tied to branches beyond his reach by the convulsive grip of a circle of bone, muscle, and sinew that relaxes only in decay.

Lest in this composite sketch of Howler life we should forget that the Howler is an individual as well as a species, I insert here extracts from my journal describing specific incidents in Howler biography. The first records the events of a presumably normal afternoon of the Howler's day; the second, their actions in response to an unusual happening.

"February 6, 1928. At noon today a party of ten Howlers came to the 'acacia' tree over my house to eat the fresh, new leaves. They fed for about twenty minutes, quietly but actively, then one after another dropped into the adjoining densely leaved tree to the westward. After luncheon I discovered them

in the upper branches of the large *Ficus* that overshadows the termite yard near the entrance to the forest, preparing to settle down for the afternoon. They were scattered about the tree-top, each one seeking a bed to its liking, some on large, horizontal limbs, others in broad crotches. I got a chair and my 24-power binoculars and camped below them.

"A female held a baby which looked not more than a week old. It was yellowish brown from crown to tail, had very little hair, and its eyes seemed barely open. It climbed over and under her with hesitating, tentative steps, its tail writhing like a snake that is held by its head. Occasionally it rubbed its cheek against its mother. While she was not demonstratively affectionate, she seemed a patient, kindly creature. She had rather a fine, intelligent, thoughtful-looking face, with large, steadfast eyes set far apart. When she moved about, the baby clung to her belly, its arms grasping her sides. When she sat crouched, it nestled in her abdomen as though it were a pouch, and she held one arm about it. If I moved I could see her somewhat protruding, wide-open eyes fixed intently on me. At times she apparently did not wink for as long as forty seconds.

"Another mother was nursing at her full breasts a young one, half her own size. It was perceptibly larger than Claudia (see beyond) who is at least five

months old. While it sat by her side, after nursing, the mother picked a nearby bunch of leaves, but after one mouthful they were taken from her hand by the child from whom, after it had eaten several leaves, she retook them. There was neither offering nor snatching, and the transfer from one to the other was made with perfect good nature.[1] The young one had a growth on each side of its neck as large as an egg, each with an orifice in the center. Evidently they contained bot-fly larvæ. Nevertheless, this animal seemed to be in good condition and spirits. For nearly half an hour it played with a companion of about its own size. One, hanging by his tail, began to tease the other below who at once responded and a mock biting-match ensued. Then the one above came down and a wrestling match followed, an active rough-and-tumble set-to on a comparatively small limb nearly one hundred feet above the ground. As one started to leave, the other pulled him back by the tail and the mock struggle was renewed. It was all pure fun, and not once, so far as I could tell, did they cross the bounds of play.

"Meanwhile, a very little fellow skylarked about them and was casually cuffed at when he came near

[1] Two days later, in watching this clan pass from the *Ficus* westward into the forest, this overgrown baby was riding on its mother's back. When she reached a place requiring a short leap she evidently realized that she could not make it under the handicap of so great a weight. The young one was therefore apparently told to dismount and go it alone, which it did quite as easily as its mother.

enough. Finally they tired; one stretched out full length on his side on a horizontal limb; the other, sitting up, spread his arms on a limb about the level of his chest and rested his head on them. The wind rustled in the sunlit branches; patches of blue sky and pink bignonia blossoms showed through the leaves; and all the Howlers, but the irrepressible little one, slept. It was an idyllic picture of life primeval.

"At 4 o'clock they began to awake and move slowly about, feeding on the leaves of the *Ficus*. Gradually they passed back toward the acacia, distant only two trees from the one in which they had been feeding. Within a half-hour they had all returned to it, and were eagerly eating the buds and new leaves. As they reached out and drew in the branches, sometimes breaking them, I was reminded of youthful experiences in cherry trees, but where I picked the fruit they bit the buds or leaves direct from the branch.

"There were in all ten individuals plus two young carried by their mothers, for in addition to the little yellowish fellow I now discovered a slightly larger baby, black in color. He rode on his mother's back, far behind, and when she stopped he sometimes ventured a step or two away from her to gather a bud or leaf for himself. I saw only one adult male. They fed for fifteen minutes then went eastward, back to the forest whence they had come at midday.

"After being with these animals for four hours, seeing them, with the aid of my glass, as clearly as though they were distant only a few feet, and hence near enough to be impressed by their individuality, I felt as though I had passed the afternoon with the family of a native tribe. The only sound heard from them during this period was a single roar in response to a passing airplane. Meanwhile Claudia who, either through sight or smell seemed aware of the proximity of her kind, called from time to time, but her voice was unheeded. In me they showed the keenest interest, but with the little captive of their own clan they had no apparent concern. Possibly they had heard her so often during the four months since her capture that they had ceased to react to her pleas for attention."

The second quotation from my journal is entered under date of December 23, 1928. It records a catastrophe. The laboratory clan was again feeding in the acacia tree, which this season had acquired its new leaves much earlier than in the two preceding years. The group now contained twelve individuals in addition to two young in arms, and was following much the same routine as before, sleeping in the forest to the east and frequenting the acacia tree morning and afternoon. The journal reads:

"At about 10 o'clock this morning the Howlers

roared frequently, without apparent cause, from the trees east of and near the acacia. On investigation the clan seemed unusually scattered. Some were in the large *Ficus* over the termite yard while others were over the edge of the barranca above the Lutz Trail. The latter group, as I drew nearer, seemed exceptionally vocal. There was a murmur of inarticulate notes, a long-drawn *eep-eep*, a louder guttural, throaty gurgling and, particularly, an insistent squawking. All these notes were new to me, and it seemed evident that they were evoked by some unusual occurrence in Howler life. It took less than a minute to discover that the squawking proceeded from a baby Monkey who had evidently lost her hold and fallen to the ground. She seemed not more than a week or two old, was about twenty inches long, of which one-half was tail, and was scantily covered with yellowish hairs. Every inch of her poor scrawny little body seemed diseased, and in her neck were three fly larvæ, each as large as the end of one's finger.

"Possibly her fall was due to weakness occasioned by her physical condition. While about three-fourths of the clan remained in the trees overhead, three individuals seemed especially concerned with the fallen baby. All were adults, one a male, one a female, while the sex of the third I could not deter-

mine. They sat together on a vine about twenty feet above the constantly calling baby. In spite of my attempts at concealment, they were at once aware of my presence, and although I did not go near enough to alarm them, it is possible that my proximity may have influenced their actions.

"For some time the male seemed quite as much concerned as the female. He ran anxiously to the limbs above and then returned to the vine and looked down intently at the baby. It was the female, however, that finally mustered enough courage to descend almost to the ground; then her nerve failed her and in somewhat of a panic she clambered back to the vine. This action was repeated several times but although the baby continued to call pathetically she did not go to it. I assumed that she was the unfortunate young one's mother and I later identified her as the author of a soft, crooning moan which was doubtless addressed to her offspring.

"For six hours her concern in the baby showed practically no diminution, and during this period the male was in almost constant attendance. At times he roared vigorously at me in hiding. The third individual, whose sex was undetermined, disappeared at the end of about three hours. The baby was now in a dying condition; its life was ended painlessly, and the clan disappeared in the forest to the west."

On March 10 following I again heard the unmistakable cry of a very young Howler and traced it to its source in a tall tree growing at the edge of a barranca near the end of the Snyder-Molino Trail. Here the members of the laboratory clan were gathered at the southeastern border of their range. They were clustered in one part of the tree where two females had charge of the crying baby. One was fully mature and seemed to be its mother, the other was smaller and acted as a helper. The baby, like the one that fell, was yellow, but appeared to be slightly smaller. It was evidently in pain, cried constantly, and writhed and squirmed so actively that its guardians had difficulty in holding it. First it was in the grasp of one, then of the other, and once they so nearly lost their hold that the little creature swung clear, held only by the tail. Perhaps it was in this way that the baby found on the ground had escaped from its mother. For the second time I now heard the low, crooning note uttered by the female over the Monkey that fell. Doubtless it came from the mother of the evidently suffering baby in the tree-tops. The others called in low, guttural growls unlike any Howler note I had heard before. When the larger of the two ministering females moved to another branch she carried the still crying, restless baby with her, and always she was followed by the

second smaller female who nestled closely at her side, apparently ready to help; gradually the baby was quieted and finally it rested with the one I assumed was its mother.

The condition of the fallen young Monkey shows that the bot-fly is a serious enemy of the Howler. About one-half of the adults that I have examined closely had one to three of the protuberances produced by the larvæ of this fly; usually they were on the throat or sides of the neck. From Goldman's observations we learn that Howlers on the mainland, in and near the Canal Zone, are also subject to this infestation. He writes[1]: "All the specimens obtained carried numerous large larvæ of flies, mainly in the skin on the throat, which added materially to their repugnant appearance. These larvæ were not found on the Spider Monkeys taken in the same vicinity."

To what extent, if any, the health of adult Howlers is affected by the presence of these larvæ I am unable to say, but it seems evident that if their newly born young are subject to attack they may menace the existence, not only of the individual, but of the species. The Howler's arboreal habits render it comparatively safe from predatory mammalia but it is apparently defenseless against this parasite.

Man, also, is not immune from these larvæ. Mr.

[1] *Mammals of Panama*, Smithsonian Misc. Coll., Vol. 69, No. 5, 1920, p. 229.

Harry Watkins, of Lima, Peru, told me of removing fourteen of them from one person in southeastern Peru. While man cannot protect himself from infestation, he has devised various effective ways for ridding himself of larvæ. But the Howler is helpless.

It is possible that when one of their kind is handicapped by the results of infestation it is banished from the clan and condemned to a life of solitude. From February 1 to March 1, an adult male who appeared to have suffered this fate lived near the laboratory. In addition to the larvæ in his neck he had lost the sight of his left eye. Its socket was either empty or much shriveled, while on the supra-orbital ridge there was a large protuberance, possibly the result of larval infestation which may have caused his blindness. A female so affected would doubtless have been permitted to remain in the clan, but an adult male could hold his place only when in possession of all his powers. The saturnine appearance of his kind was heightened by his afflictions, and one could easily imagine that continued brooding on his misfortunes had not increased the sweetness of his expression. This individual was seen almost daily and always he was alone. Occasionally he roared briefly, but only Claudia, a friend in misfortune, answered him.

THE CONQUEST OF CLAUDIA

This sketch, embodying my casual observations on the Howlers of Barro Colorado, has taken us from the species to the clan, and, very briefly, the individual. It may be concluded by abstracts from my notes on a young Howler in captivity. The habits of our pets, like the doings of our children, are very apt to arouse in us an enthusiastic approbation not always shared by others. But it is universally admitted that Claudia, as she was called, was possessed of a fascinating personality. If it is difficult to analyze the bases of personality in man, how can one hope to do it in a baby Monkey? I can only say that Claudia had large, luminous, intelligent, in fact, human black eyes, and that their distance apart gave breadth if not height to her forehead. From them she regarded you with a spirit of calm, discriminating independence which was the essence of her nature and perhaps the foundation of its charm. Claudia might, with reservations, be your friend, but she certainly was no one's pet. She permitted no petting and she displayed no affection; and still I felt that Claudia had potential affections and I knew that it was well worth an effort to win them.

It was in October, 1927, that Claudia literally fell into our hands. At this time she was about two

months old. She was a member of the laboratory clan of Howlers and, doubtless by some mishap, was left alone in a tree near my house whence she was taken by Donato. It was the 23d of the following December when first I met Claudia, and two pages of my journal of the 24th are devoted to her. From it I quote:

"The baby Howler is captivating. No hand-organ Monkey this, but a wild, forest creature who after two months' captivity out of the not more than four of her life is still unapproachable. She resented the slightest touch and turned on me fiercely. For a moment I thought that she actually would attack but she vented her feelings by howling loudly. When I came from the forest at midday she was lying on her back, arms outspread, in the bottom of her cage, to all appearances dead. But she slowly opened her eyes, looked at me dully, and, with apparent effort, raised one arm. I was quite sure that she was dying, and went to my house for a poncho to protect her from the burning sun. When I returned she was up, grunted a little, and soon began eating. Evidently I had aroused her from a nap.

"In the afternoon we removed her from the cage, which she had shared with two simpering Marmosets (to whom she paid not the slightest attention), and

placed her in one of her own where she would have the seclusion her reserve demanded. It is a large cage nine feet square and seven high, and in its center we set a small, well-branched tree with the leaves still attached. It was fifteen minutes before she ventured into this new field. Meanwhile, she sat on a box similar to one in her former quarters. The moment she entered the tree she began to eat its leaves, pulling them in toward her as the adults do. This important food had been omitted from her diet of bananas, rice, papaya, bread, and meat. Of the latter she seemed very fond and at 1 o'clock today was tugging at a piece held in her left hand. Changed to the right hand there was an evident lack of coördination. Mouth and meat did not connect until the left hand came to the rescue and guided the right toward the expectant point. Apparently she is left-handed. After a survey of her surroundings, she made a journey of exploration of her new home, climbing from limb to limb, moving easily and freely, making some missteps but saving herself from falling by the use of her tail, an automatic mainstay. She howled loudly and repeatedly at an airplane, the approach of which attracted her attention before it was visible—a valiant little baby, born old."

Claudia's actions on being placed in new surroundings proved to be wholly characteristic. She was

always intensely curious, but it was curiosity controlled by caution. Nothing was too insignificant to arouse her interest and warrant investigation. Even a small stone that chanced to be dropped on the dirt floor of her cage was approached by degrees and from all sides and was eventually tested with her teeth.

She would try any food once but promptly dropped what did not appeal to her. Raisins she would always take. The seeds cracked sharply as she munched them. The skins were thrown away. If the raisin fell before she had extracted its contents, she looked down from the limb on which she was sitting until she saw it on the dirt floor, then went down and retrieved it, a perfectly coördinated bit of action.

A vessel large enough to bathe in, which was placed in her cage, was finally tested, like the stone, with her teeth. She made no attempt to enter it and evidently considered water as designed only to drink. In that way she used it freely, but an attempt to give her a shower brought such pitiful protests that we at once desisted. Howlers evidently do not bathe. A rope hung from the roof to the floor of her cage, about two feet from the tree, met with immediate approval. Here was something in the nature of a vine to which she needed no introduction. Her first motion was to reach for it and pull it in, hand over hand, as deftly as a sailor. Then she sprang for

it, or, at times, went to ground, took the loose end in her hand and, walking erect, carried it to the base of the tree which she ascended, taking the rope with her. Thence she swung to a perch placed on the opposite side of her cage. It was some days before she ventured to swing free to and fro on the rope.

When in her tree, whether in motion or at rest, the tip of her tail was almost invariably wrapped about some convenient branch. It functioned as automatically as her feet. When she leaped for the rope she did not abandon her tail-hold until the rope was grasped. To test the effectiveness of this safety device I pulled the rope aside just as she sprang for it, but in spite of the fact that to her weight was added the momentum of her spring the tail always held. She stopped, it is true, with a jar, but she stopped.

The great event in Claudia's life during the three months I knew her was the placing in her cage of a fresh tree. To her it was a new world. Like everything else new, she viewed it with suspicion and approached it by degrees, making tentative advances from the ground and from her rope, both familiar territory. Gradually she increased her grasp on the ends of the new limbs, testing them with her teeth, and after about ten minutes she severed all caudal connection with the world behind and entered

the tree. Suddenly, panic-stricken by the strangeness of her surroundings, she made a rush for safety on the sides of her cage. This was repeated time after time, minute inspection accompanying each visit until she had thoroughly explored her new kingdom and began to feel at home in it.

If Claudia seemed overcautious it must be remembered that she was almost wholly without experience and had no one to instruct her. In her clan she would still have been in her mother's arms, and never called upon to take the initiative or reach a decision unaided. Alone she had nothing to guide her but her own good sense, courage and instinctive prompting to be cautious, and the manner in which she accepted the numerous changes, small and great, in her new environment is a tribute to her adaptability. Unfortunately, there was no one at the laboratory during this period prepared to make a proper study of Claudia's mentality and development. To me she was only a very appealing, winning little person with whom it was always a pleasure to spend a minute or two of the time left from other occupations.

One day I placed a Tovi Paroquet in her cage. She looked it over carefully, as she did everything, but it did not seem to impress her. Nor was she especially concerned with a Coati that sniffed around

the outer base of her cage. But a live, native mouse (*Oryzomys*) at once claimed her entire and eager attention. From a branch of her tree she followed its every movement as it ran quickly from side to side trying to find an exit from the floor of her cage. Frequently she uttered a sound like the gritting of teeth and to it added a high, excited squeak. It did not seem possible that so arboreal a creature as Claudia could have an inherent interest in an animal so terrestrial as a mouse. Nevertheless, it unquestionably fascinated her. So great, indeed, was her desire for a closer view of this strange, active little object that it prompted her to descend to the ground. Barely had she reached it when the mouse chanced to run toward her and, with a convulsive leap, she sprang upon a nearby block of wood, back arched, tail tightly curled, jaws set, eyes intent with a look which seemed to express mingled fear, surprise, and indignation. It required only a little imagination to believe that we had here a primitive exhibition of a response which is commonly thought to be instinctive in Claudia's remote relatives of the same sex! The little excited squeaking aroused by the presence of the mouse was always uttered by Claudia when I shook the gunny-sack, which was her bed, as an invitation to play. At such times she jumped toward the sack to grasp it with teeth and hands.

The grating sound indicated contemplation. It was sometimes continued for more than a minute. While eating she often uttered a low, contented chuckling, and her only other conversational note was a slight grunt, at times leading up to a roar. Doubtless Claudia was just as well pleased to be left largely to her own devices. When not distracted by the presence in the nearby forest of her own kin, she never seemed to lack for occupation. Her tree and swinging rope made a playground where for hours at a time she entertained herself, performing rare acrobatic feats. When tired, she often rested by straddling a horizontal limb, lying on her belly with her hind legs dangling and her chin leaning on her folded arms. From this evidently comfortable position she surveyed the world composedly and with what seemed to be a slightly amused expression.

When taking her mid-day siesta she sought a place, either on a box or the bottom of her cage, fully exposed to the sun, lay flat on her back and stretched her arms and legs out to the limit of their reach. I have never seen any other quadruped, and but rarely a biped, assume so relaxed a pose. At night she slept in a box, with a piece of gunny-sack for a bed, usually lying on her side.

Aside from Claudia's attractive personality I think that it was largely her evident disregard of me that

Claudia in a Contemplative Mood

Claudia's Midday Siesta

Claudia Howls

Claudia Reacts to a Mouse

led to a determination to win her friendship. Also I was influenced by the fact that Howling Monkeys are notoriously untamable.

I deliberately devoted myself, therefore, to the conquest of Claudia. It was slow work. She had no more time for me than I had for her. It was doubtless just as well, therefore, that I could make only brief and casual visits when I chanced to pass her home. My campaign was planned on Claudia's love of food and play, two traits on which we might meet with some hope of understanding each other. The story of how I gradually gained her confidence may best be told by extracts from my journal. It will be remembered that I first met Claudia on December 24:

"December 25. Photographed Claudia this morning. She wanted to sleep and resented being disturbed. She did not howl at me as she did yesterday, but beyond this is no more friendly. She refused to take food from my hand but picked it up from the box where I placed it. She appears to be definitely left-handed.

"December 26. Claudia took food from my hand and even ate while I held it. We are getting on. A piece of banana, Brazil nut, cabbage leaf, and a bit of cooked meat were all accepted, although the nut and cabbage were certainly new to her. Both the latter were soon dropped, but the meat she clung to

with her left hand eating eagerly and chewing thoroughly before swallowing. She has not yet cut all her teeth and none seems fully grown."

During the following month I made some progress with Claudia, but without gaining her confidence in my good will. She soon came to recognize me as a source of unusual and palatable foods, but I myself was altogether too remarkable an object to be accepted without reservations.

Often as I entered her cage she jumped toward me from her tree to the rope and held out her hand (usually the left) for the expected gift. I tried to induce her to eat while still I held it as a means of creating closer relations, and she frequently did so, very gently, sometimes tentatively testing my fingers; but her teeth, if small, were sharp and I did not encourage experiments in this direction.

As a playmate I got nearer to her. Her love of play seemed quite as strong as her desire to eat. When, about half an hour before sunrise, she awoke she went direct from her box to her swinging ropes. A second rope had been placed in her cage and she seemed never to tire of devising new methods of using them. It was with a rope, therefore, that I made my advances, and she quickly offered to bite one end while I pulled at the other. A puppy acts in much the same way. Now and again she seemed

to realize that she was becoming too intimate and retreated, but each time the lure of the wagging rope won her to a new test of strength; and for a baby she was amazingly strong! Eventually she entered into this game with so much zest that even when her only hold on the tree was with the tip of her tail, shake and swing as I would she did not relax her grip. Her tail, indeed, seemed to be quite as firmly attached to the tree as to her body. But in spite of these associations she would not permit me to touch her.

An incident that occurred on February 7 did much to advance our relations. Attracted to her cage by unusual calls, we found her so entangled in her ropes that she was completely helpless. She was terrified and, as we cut her bonds, screamed like a child. When freed she was a very much subdued Monkey, and either for this reason or because she recognized in me a rescuer, was very gentle, eating from my hand and almost permitting me to touch her.

Five days later, or after a siege of just fifty days, Claudia capitulated. My credentials, however, were still supported by an appeal to her palate, and it was while she was eating a raisin that I was granted the heretofore unthinkable familiarity of stroking her head. The act, indeed, seemed to give her some pleasure and it had all the elements of a personal

victory for me. Finally she stretched out on her gunny-sack bed, put her head on one side, closed her eyes and, with every appearance of contentment, confidence, and relaxation, went to sleep under my continued ministrations. I rejoiced in the conquest of Claudia.

After this epochal event our friendship developed rapidly, but on Claudia's lines; and Claudia's lines were play, more play, and harder play. She would desert her food at any time when I entered her cage and spring toward me. Indeed, Claudia now became the aggressor. I was, in effect, another rope and to be used as such. Meanwhile Claudia's teeth had become formidable. She never attempted to bite, but her methods of play called for their more vigorous use than my skin was prepared to withstand. I had, therefore, to cover one hand with a woolen sock, leaving much toe for chewing purposes. This seemed to please her and it protected me while with the other hand I could maul her freely. Was Claudia now tamed? Not for a moment. I was simply one of the many strange things which she had encountered in her new environment, learned to accept and make the best of. Fundamentally she was as wild as the day of her capture. It needed only the sound or sight of her own kind to change her from an apparently happy little creature playing with her

ropes, to a wild animal dashing about her cage or clinging to the wires nearest the forest and howling pitifully.

Her powers of hearing and seeing were remarkable. Often her calls first told us that Howlers were roaring in the distance or passing through the trees bordering our clearing. As time passed and she became more accustomed to confinement and familiar with us, we assumed that she would cease to respond to the "call of the wild," but there appeared to be no decrease in the force of her reaction to the voice or the presence of other Howlers.

My record for December 24 reads: "This afternoon Claudia howled continuously for at least half an hour. Evidently she was startled by hearing some of her kind, but they were so far away that one had to listen intently to hear them. She jumped from limb to limb of her tree angrily shaking its branches with her hands and even biting them."

Under date of January 21 I quote: "Claudia is wild and restless. She calls almost constantly and rushes about her cage floor, always on the forest side, as though looking for a way out . . . . She was not still for thirty consecutive seconds during the day."

As before, this activity was caused by hearing Howlers call. Then would follow a period when there were no other Howlers in our vicinity and Claudia

seemed wholly reconciled to cage-life. But with the return of the cause she would have another violent, uncontrollable attack. One could not imagine cries more expressive of hopeless despair, or a more pathetic figure than this baby Monkey looking from her cage to her relatives in the tree-tops and moaning wistfully.

At this time we should have yielded to Claudia's plea and restored her to her clan. Perhaps they might have refused to accept her, but even if forced to live alone she would have had the freedom of the forest, and one must believe, eventually, have found a mate.

At any rate she could have suffered no worse fate than befell her in our care. Gradually her health failed until she could barely drag herself into the tree through which she had leaped and swung so agilely; and in October, 1928, a year from the date of her capture, she died. Her body is in a jar of alcohol in the laboratory awaiting dissection to determine the cause of her death. I have never had the courage to examine it. Whatever the autopsy may show I believe that Claudia died of a broken heart.

CHAPTER XII

PRESENTING THE COATI

HEREWITH I present the Coati or Coatimundi, *Nasua narica* of science, "Pisote," "Gato Solo," and doubtless many other names in the tropical American countries in which he lives. His nearest relative is the Raccoon, which he resembles in size, appearance, general habits and disposition. The Coati has a longer tail and a longer nose than the Raccoon, and both these members function in ways well designed to express the character of their owner. The tail is usually carried jauntily erect or pointed slightly forward, with a reverse curve near the tip which makes it suggestive of a combined periscope and interrogation mark, indicative, perhaps, of the Coati's inquiring nature. When in doubt as to your next move, Coati swings his tail sinuously from side to side, with, if one can imagine it, a kind of quizzical motion matched by the twinkle in his eyes, for Coati is not only a most responsive creature but, beyond question, has a love of play.

Coati's long, almost prehensile nose houses a highly developed olfactory apparatus which evidently brings

him more information than do his eyes. Indeed, I have seen him with closed eyes and curling nose sniffing this side and that in an effort to locate the source of a scent.

If, when walking along the trails on Barro Colorado, I hear a diffused rustling with now and then a ripping, tearing sound, I know that a band of Coatis is foraging through the undergrowth. If these noises decrease, I follow them cautiously; if they increase, I remain motionless. If the foragers do not get my scent I am likely to see them whether I go to them or they come to me. They are not extremely shy animals and seem to rely largely on their sense of smell to warn them of the presence of danger. Both eyes and ears function keenly, but the hunters are so intent on the chase that unless I am betrayed by the wind I can approach them closely.

The noises made by their varied activities now become louder and more definite. If the leaves are dry there is the sound of many footsteps, of scratching here and there, of the pulling of bark from old stumps, or the tearing apart of decayed logs in a search for grubs. There is a sniffling, snuffling, and grunting with occasionally a sharp note of protest when ownership of food is in dispute. No attempt is made to move quietly; a troop of hogs might be rooting through the forest.

A Coati Fires the Flash

The animal's right forefoot is on the trip-wire

A Coati Takes Possession of a Banana Plant

These bands are composed of females and their young and may contain from fifteen to forty individuals, or approximately three to eight families. The young are born from April to August and remain with their mother at least until the following spring. The adult males are usually found alone.

On one such occasion six half-grown young—doubtless a family—passed within twenty feet of me. They were nosing along, trying the air, first one side then the other, prying here and there, or stopping to dig and snuff. Suddenly there was a wild scurry, followed by absolute silence. Two of the six young failed to get away. Probably they were too frightened to know where to go so they "froze" in their tracks. For nearly a minute they remained motionless, crouching low and obviously unaware of my presence. Then they crawled slowly and cautiously after the others. Evidently some one of the band of twenty-five or thirty animals had caught my scent and given the alarm. It was unheard by me, but loud enough to reach the youngsters near me, and the promptness with which they responded gave evidence of the strictness of their training. There was no stopping to ask questions—they obeyed. Within ten minutes, doubtless having passed more to windward, the band was on its devastating way again.

Not infrequently our meeting is mutually sur-

prising. The probability of encountering a larger animal on Barro Colorado makes one rather sensitive to suggestive sounds, and the sudden *woof-woof* and quiek rush of feet make one "frceze" likc the young Coatis. Meanwhile; the Coatis, being more active, have sprung up trees and you see them here and there, elinging to the bark six to ten feet from the ground, looking at you intently and uttering low, grunting notes.

At once you are impressed with the animals' personality. They are not unresponsive Squirrels, Cats, or Opossums, but intelligent, perceptive creatures thoroughly aware of your presence. Under these eircumstances I always address the Coati nearest to me and, reaeting to its expression, I adopt a sort of hail-fellow-well-met attitude, saying something like "Now see here, old ehap, I'm not in the least dangerous and there's no reason in the world why you and I shouldn't be good friends." I have no doubt that if the Coati understood me he would take me at my word. But both as speeies and individual I am a stranger who has still to win his confidence. He is very much at a disadvantage as regards size and there appears to be no real reason why he should run any risks. Nevertheless, he shows an evident desire for closer acquaintance. I like to think that my attitude and voice disarm suspieion, but it is doubtless

curiosity that prompts him to descend a step or two. His long tail curves and undulates with silent eloquence, and he tosses his head with a graceful, coquettish, colt-like movement as he seems to reply, "What you say *sounds* most interesting, but this whole situation looks pretty queer to me. It may be all right but I don't *see* anything in it for me, and if you don't mind I think I'll play safe." So down he jumps and scampers off through the forest.

This habit of bounding up a tree when surprised is an interesting one. Primarily the Coati is terrestrial and in escaping an enemy he keeps to the ground, but his first impulse when frightened is to take to a tree. Here, for the moment, he has acquired a safe point of vantage from which he may survey his surroundings. Then, having located the source of alarm, his next move is governed intelligently. If forced to he may ascend his tree of refuge, but usually he hops to the ground and makes off through the undergrowth.

"Safety first," however, is not always the motto of the female Coati, and, when encountered with young not old enough to look out for themselves, she may take the aggressive. In August, 1926, Frank Drayton, then resident custodian on Barro Colorado, met six or seven female Coatis hunting with their young families. He stood motionless and one

mother with her young came to within four to five feet before discovering him. The young at once took to the nearest trees where they whined with fear, but the mother sprang boldly at Drayton and would have landed at his waist if he had not parried her attack with his cane. He then backed off while Coati, calling her young to her, hurried away with them through the forest.

Although Coatis prefer the ground, they can climb with almost the agility of a Monkey. Omnivorous feeders, they seem as fond of fruit as of grubs, and when some favorite fare is ripe (notably the large, thinly coated seed of the almendro) they haunt the tree bearing it. Fallen fruit may be left for Peccaries and Agoutis; the Coatis want the best there is and are willing to go for it. Apparently nothing is beyond their reach, and they go to the tree-tops and ends of lateral branches that bend beneath their weight. Surprisingly enough, their long tail, unlike that of American Monkeys, is not prehensile. When climbing it serves merely as a balancing-pole and is swung from side to side without ever grasping a limb. Place this restriction on a Monkey, whose tail at times takes the place of all four feet, and the Coati, thanks to the length and strength of his claws, would doubtless prove to be the better climber. When discovered in a tree, even if they be a hundred feet or more above

the ground, Coatis at once start downward and, when in numbers, their rapid descent creates the impression of a cascade of animals. They pour down the branches and trunks, so intent on reaching the ground that often they pass within a few yards of the innocent cause of the commotion. On one occasion of this kind, beneath a fruit tree growing eighty yards from our laboratory, a single observer counted thirty-five Coatis pass him, while an unknown number escaped by other routes. Probably this band contained not less than fifty individuals. This was in February. All were full-grown, and one has only to imagine half a hundred Raccóons going at top-speed through the trees to realize that here was a scene of considerable animation!

The adult male Coati evidently leads a lonely life. Banished by his family, he seems to have a standing engagement to fight with others of his sex whenever his paths or purposes cross theirs. The papayas, plantains, and bananas growing about our laboratory attract numbers of these solitary animals. Their continued presence gives us an opportunity to promote an acquaintance denied us by the animals we chance to meet in the forest. Furthermore, our plea for more intimate relations is accompanied by the offer of food.

The response differs with the disposition of the

animal and ranges from complete lack of confidence in our motives to absolute conquest. There was one individual, whom we never knew even well enough to name, who accepted our bounty but refused us his friendship. Finding a bunch of bananas approaching maturity, he took possession of the plant bearing them, mounted to a comfortable lookout above the fruit, and declared his ownership. Possible trespassers were warned off with sharp, bird-like notes, and so effectively did he proclaim his nine points that they were accepted as law. When hunger prompted he descended to his storehouse and leisurely supplied his wants. Then he returned to his perch to doze. But never was he too sound asleep not to be aware of the appearance of a possible rival to his claim, and he always took the initiative by asserting his rights before they were challenged. This state of affairs lasted for nearly three days when, the bananas having been consumed, he descended to earth and the level of the average Coati.

Of a very different temperament was an individual whom in due time we named Peter. To Drayton belongs the credit of winning Peter's friendship. In him are strongly developed that patience, gentleness, and sympathy with animals which are required to induce a wild creature to overcome its innate suspicions and literally place its life in your hands.

Day by day the distances at which bits of banana were retrieved were shortened, and with the gradually closer approach there seemed to be an intelligent appreciation of his changing relations. The quaintly tossed head and nervously twisting tail of the animal of the forest gave way to a look that seemed to say "Now just what does all this mean?" It was doubtless the first time in his life that Peter had been given anything but his mother's milk.

The answer to this question, if it were a question, was more bananas and shorter distances. At length a bit of banana was offered at the end of a long stick; but even when this was held just above other pieces they were deftly extracted with a catlike sweep of the long-clawed forefoot and the impaled piece above them ignored.

But a lessened sense of danger, combined, perhaps, with a growing love of bananas, finally induced Peter to risk his all and take a banana from Drayton's hand. It was done, however, with a grab and a panic-stricken retreat, but it was done and no harm followed. Then the banana was held more firmly so that only a bite could be taken at one time. This was eaten after backing off several yards. Still no evil resulted and, in the end, Pete, as we now called him, put his hands on the one that held the banana while he quietly enjoyed his meal.

Morning and afternoon he now waited patiently outside the door, and if food was not forthcoming he mounted the steps high enough to look over the baseboard, through the screen, to see what that banana-man was doing. We actually found his foot-prints on the door-knob, though we did not accept this as evidence that he had become sufficiently versed in the ways of mankind to understand the mechanism of a latch.

So, one by one, the little citadels of fear in which all his life Peter had sought refuge, capitulated to a siege of kindness and bananas. He even permitted his nose to be rubbed and back to be gently stroked, and seemed to like these caresses—doubtless the first he had ever received. How far his conquest might have been carried we do not know. With the return of the mating season impulses stronger than a love of bananas carried him to the forest and a brief period of family life.

We had hoped that in time he might fill the place of the lamented Tudy, a Coati captured when she was only a few weeks old. Reared carefully by Drayton, there developed between the two a rare comradeship and affection. They played, they fought, they hunted together. They even slept side by side, Tudy placing her head on the pillow and stretching out her legs to occupy her half of the bed

A Coati Portrait

The Taming of Peter

A Coati Attacks

This animal resented the shaking of a bunch of keys and sprang at the shaker
(*Photographed by James Zetek*)

like a well-behaved child. She seemed in a fair way to reverse the history of the lady who became a fox.

Then came the call of her kind. Stronger than any human attachment, it was not to be denied. Always at liberty, she made increasingly frequent visits to the forest, returning somewhat dishevelled but evidently glad to be home again. Sometimes Drayton would follow her to the forest. He could recognize her at a glance and, in response to his call, she would leave her newer friends and come to him. But repeating the fate of her vulpine prototype, she finally disappeared.

News of Peter's surrender and its reward apparently spread through the forest, and within a month the laboratory became a focal point for unattached male Coatis. With the quick adaptability of an intelligent animal, they soon discovered that it was far easier to ask for food than to hunt for it, and their demands soon became so insistent that at times, when the supply of bananas became low, we had actually to avoid them. It was a striking instance of a change from wholly feral to almost domestic habits. There was, however, no change in the interrelations of the Coatis. They were indeed on far better terms with us than they were with each other—a fine illustration of how two animals of different habits may live peaceably in close contact.

When his mastery was accepted, a male permitted one or two other, and doubtless younger, males to come near him, but, as a rule, each one had his own territory on which he promptly resented trespass.

It is when Coati meets Coati that the higher uses of their nasal appendage are demonstrated. The phrase to turn up one's nose then receives new and eloquent meaning. Never is contempt more plainly written on an animal's countenance than when a Coati curls his nose at a foe and with low, pig-like grunts and whinnying squeals advances to the conflict.

Usually the trespasser retreats before these facial and vocal manifestations, but if battle be given it is fought without gloves, and the long canines and longer claws are dangerous, even deadly weapons. Most of the individuals who had established themselves at the laboratory bore the marks of conflict. One had lost an eye and had an open wound in his side. Food we could give him but not protection, for he had been too long free to accept confinement or to understand that it meant safety.

How long, we asked, could he hold his own among his merciless kin? No animal, it has been said, lives to reach the physical three score and ten of his species. So keen is the struggle for existence, so evenly balanced the chances of life and death that

when one is past its prime or, through mishap, has its vital forces diminished its days are numbered.

So we kept our eye on Old Battle-axe and he kept his hold on us so closely that in his final extremity this wild, stricken creature, who had known human association only a few days but had known the ferocity of his kind all his life, pushed open the swinging door of our basement and sought sanctuary with man. There, before morning, he died. When, therefore, I am asked what are the principal enemies of Coatis, I reply "Coatis." In their search for food they compete more closely with their own species than with any other. In their search for a mate they compete only with their own species. Choice of food may vary and there is a wide and rich field to select from. Choice of mate is restricted and there is abundant reason to believe that the demand is in excess of the supply. Thus it follows that one of the most frequent causes of combat—and hence of death—among Coatis is sex rivalry. It might be thought that since only the males fight they alone would suffer but, as the following incident shows, the female may also be the victim.

Drayton, inconsolable, and ever seeking to fill the place in his affections made vacant by Tudy's desertion, had caught, about six months before, a young female Coati. Although only a few weeks old

at the time of her capture, she never ceased to resent it. In vain she was wooed with kind words, gentle treatment, and a variety of food. Every advance was repelled; she would have none of us. It was Coati, not human association she craved.

An ailing male of about her own age, that Drayton found near the laboratory and brought in to care for, was greeted with evidences of joy. The afflicted little creature died during the night and in the morning she was found nestling against its dead body.

Admitting defeat, Drayton determined that "Billie," as he called her, should no longer be deprived of congenial companionship. So he released her, and with snickers of delight she at once went to one of our male visitors. He was not very cordial at first, but eventually they became friends.

One evening, as we were at supper, she was playing near him when we saw another male leave the forest and come up the hill through the narrow clearing toward them. As soon as he saw Billie he rushed at her. The home male defended; there was a confusion of bodies and cries, and, within thirty seconds, the invader left, bearing Billie in his mouth. Drayton ran to the rescue, the overburdened captor dropped his victim, and Drayton brought her home in his doubled hands. Her back was broken, she was bleeding profusely, and died before we could give her

chloroform. Silently we returned to our meal, in the shadow of an almost human tragedy.

POSTSCRIPT

During at least the first half of the dry season Coatis are now so common and familiar about the laboratory that one might well believe they had always been present in this semi-domesticated condition. I print, unchanged, therefore, the preceding record, written in March, 1927, of how the first Coati was tamed, as a contribution to the Coatis' post-laboratory history on Barro Colorado. The life of no other island vertebrate appears to have been so greatly affected by the presence of man. In the immediate vicinity of the laboratory this is rendered impressively evident by the abundance and tameness of Coatis, due to an increase in their food-supply and their comparative loss of fear. In the less-frequented parts of the island their attitude toward man seems unchanged, but it is the generally held opinion that everywhere these animals have become more numerous. It is probable, therefore, that the undue abundance of the Coati will present us with our first problem in deciding what steps, if any, we should take to maintain the apparently balanced conditions which have existed in the island's life during the five years of the laboratory's history.

It is difficult to name the environmental conditions which have given the Coati an undue advantage over the other members of the fauna with which it might come in competition. It has been suggested that the increase in the numbers of the littoral Iguanas and Basilisks, following the insulation of Barro Colorado, has added to the Coatis' food-supply; but, as I have said in an earlier chapter, the shores of the Chagres and other streams drowned by Gatun Lake must have supplied these lizards with favorable haunts. Furthermore, both the Ocelot and Puma, doubtless the only large predatory foes of the Coati on Barro Colorado, are also said to feed upon Iguanas; and if they also prey on Coatis they have been benefited by an increase in two sources of food; the Coati by but one.

The question is an exceedingly interesting one, and our inability to advance a plausible reply, even under the restricted and comparatively well-known conditions prevailing on Barro Colorado, well illustrates the difficulty which attends any attempt to learn the factors which govern an animal's numbers. It should be pointed out, however, that no one has made this problem his own, and it is admittedly far too complicated to be solved by casual observations.

Of greater importance is it for us to determine the effects of the undisputed increase in our Coati popu-

lation. No one who has seen a band of Coatis rooting, ripping, tearing, digging their way through the lower growth or witnessed the ease with which they can transfer their operations to the tree-tops can doubt their potential destructiveness. Looking over the scarred ground in the wake of ravaging bands, one marvels that any terrestrial form of life large enough to serve as food escapes them. I should think that ground-nesting birds, and certainly their eggs and young, would be at their mercy. With this thought in mind I have observed closely the two species of Tinamous, the Quail, and certain low-ranging Antbirds, as their presence is indicated by their calls, and I have been relieved to find that these birds were apparently as numerous in the fourth year of my observation (1929) as they were in the first (1925).

If, however, the Coatis continue to increase it is difficult to believe that these birds can longer hold their own. But how long will the Coatis grow in numbers? When will the island population of this species reach the saturation point? Earlier in this chapter I have said that the chief enemy of the Coati is the Coati. They are exceptionally pugnacious animals and fight freely among themselves. Obviously, because of their greater abundance about the laboratory, we hear their battle-calls, like dog-

fights in a high key, far more frequently than formerly. But if our belief is correct, conditions about the laboratory merely reflect in an exaggerated degree those that are coming to prevail throughout the island. Perhaps it may become a case of *similia similibus* and the Coatis will hold themselves in check.

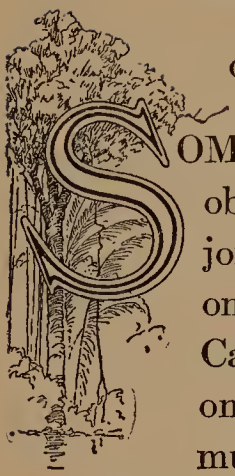
Since the earlier part of this chapter was written, we have had several additional illustrations of the aggressiveness of the Coati, which, indeed, is the only large vertebrate on Barro Colorado that has been known to attack man. On two occasions, when in the forest, Dr. J. Van Tyne was obliged to retreat before the advance of female Coatis that he chanced to encounter with their young. One of these mothers was prevented from springing at him only by firing a gun at her feet. Both these animals were evidently inspired by fear for the safety of their young, but one cannot so satisfactorily explain the actions of a Coati that for a time lived about the laboratory.

For some unknown reason this animal was infuriated by the sound produced in shaking a bunch of keys. Merely to jingle them within his hearing was to invite attack. Prompted by the spirit of investigation and demonstration, Mr. Molino of the island staff offered to fill the role of key-shaker while Mr. Zetek recorded photographically the reactions of the

Coati. The experiment was wholly successful. Each actor played his part to perfection. Molino, holding high the keys, jingled them loudly, the Coati not only sprang to his shoulder but drove his teeth in it, while Zetek made the photograph which is presented herewith. Everything seems perfectly clear except the motives of the Coati, and since neither Zetek nor Molino can explain them, and I myself did not see this incident, they doubtless will remain a mystery. In any event, it is evident that the Coati adds not a little to the interest of life on Barro Colorado.

CHAPTER XIII

TROPICAL FOREST BIRD-LIFE



GENERAL CONSIDERATIONS

SOME 230 species of birds have been observed on Barro Colorado and its adjoining waters. This is approximately one-half the number known from the Canal Zone. There are not many birds on the lake, the island has no beaches or mud-flats suitable for shore-birds, the clearings are limited in area, and the avifauna, therefore, is largely forest-inhabiting.

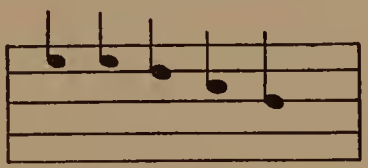
Few types of country present greater obstacles to the bird-hunter, whether armed with gun or glass, than mature, humid tropical forest. The height of the trees, the luxuriance of their foliage, the profusion of the vines and plants that are parasitic upon them, the density of the lower growth favored by birds, and the gloom that pervades it, all make both collecting and observing difficult. A silent, motionless bird is usually invisible.

For the use of bird-students on Barro Colorado, the American Museum has placed in the laboratory a collection representing most of the birds known from

the island. A study of these specimens, in connection with Mrs. Sturgis' book on the birds of the Canal Zone, makes it necessary to resort to identification by collecting only in exceptional cases.

To learn a bird's song one must, of course, see its author singing. Even with the most common species this often requires persistence and keen, discriminating vision. The Tyrannine Antbird, for example, so frequently heard in the wall of vegetation at the border of the forest, may sing, long unseen, almost within reach of one's hand.

With the rarer birds and those that sing infrequently, months of patient stalking may be required to reveal their identity. The longer a singer remains unknown the more strongly does its song arouse our curiosity. We endow the bird with a personality and speculate on its relationships, to find, perhaps, that it is not a member of even the family in which, theoretically, we had placed it. There is a bird on Barro Colorado with a very strongly marked, loud, ringing song that can be placed on our scale thus:



Transcribed by Mrs. Chapman

Sometimes I hear these notes daily; at others, not for a week or more. The bird sings only once or

twice; it may be answered from a distance by another bird of its kind; then both are silent. How many times I have followed this challenge to my birdcraft! I believe that its author is a species of Woodcreeper. Some day it will sing when our orbits are touching, and I shall learn its name. Meanwhile, with other strange voices, it is a pleasant, if somewhat disturbing mystery.

The notes of this bird, as well as those of many others, can be easily imitated, but it is exceptional for even a good imitation to act as a lure. There are birds, like the Panama Antthrush, that seem always to come to your call, but it is probable that, in most instances, only breeding birds on whose territory you are trespassing will investigate your call. Nor is the device of "squeaking"[1] any more effective. Some birds, usually those of a nervous, excitable disposition, respond and approach, but generally this method, often so successful in the north, particularly during the breeding season, is here fruitless. From all of which it follows that even an experienced observer could not in a day's outing make a census of birds seen which would begin to do justice to the existing bird population; while a novice would return with a most discouraging opinion of the numbers of birds living in the area traversed

[1] Imitating the cries of a young or a wounded bird.

Just how numerous birds are in a tropical forest is, indeed, a difficult thing to determine. Even among permanently resident species there is a fluctuation in numbers which gives markedly different results to the outings of successive days over the same territory. In the main, this variation is associated with the food-supply but it also contains an element of luck.

I recall mornings, for instance, in the latter half of December when the air about the summit of the island was animated by large numbers of circling Swifts, Martins, and Swallows whose presence was doubtless due to the periodic appearance of some flying form of insect life; but with the coming of the dry season these easily observed birds disappeared from that locality; the first-named were rarely seen anywhere. After examining the contents of their stomachs, an entomologist could probably tell why they were present, as well as account for their absence.

When I encounter a raiding column of army ants I know that in attendance there will be several species of Antbirds that I rarely, if ever, see at any other time. With the ripening of certain fruits one has only to visit the trees bearing them to see many species of birds in numbers.

These are all easily understandable illustrations of the relation between the comparative abundance of

birds and their food. But there are other relations having to do with a bird's presence or absence not so readily explained; these are the relations of a bird to its associates. Northern bird-students are familiar with the loose companies of Chickadees, Nuthatches, Creepers, and Woodpeckers so characteristic of our winter avifauna. The different species do not speak the same language, they have no direct contact one with the other, but between them there seems to exist an understanding born of some interest in common. Possibly this is their common desire to find a breakfast or dinner, as the case may be. They all appreciate the same kind of fare and, like a group of children hunting wild strawberries, all circle about one another.

As has often been stated, similar associations of birds are found in tropical forests. The trail seems deserted; neither eye nor ear detects a sign of life. Suddenly, you hear the sound of many voices as in conversation, like the gossip of a flock of Tree Sparrows, and, from forest floor to roof, birds are moving. There may be a dozen species of Antbirds, half as many Woodcreepers, a sprinkling of small Flycatchers, a Manakin or two and, higher up, some winter visitant Warblers mixed with resident Honeycreepers and small Tanagers. Some of these birds feed exclusively on insects; others eat only

fruit. It is not, therefore, a search for food that brings these two groups together, even if as individuals that be the object of their wanderings. They are far from being of "one feather," and one can attribute their association only to that social instinct which, in species, is expressed in the flocking impulse and communal nesting.

However this may be, the number of birds seen on an outing will depend on whether one visits a well-patronized food-tree, encounters a horde of army ants, or meets one or more roving bands such as I have described. Beyond these obvious factors in governing the number and variety of birds seen are others I am unable to explain. Some mornings, birds are in evidence on every side and the air is vocal with their calls and songs; one hears notes he has never heard before. The next day the woods are silent and seem deserted. Conditions may appear to be exactly alike on both days, and there is no apparent reason why birds should not be as abundant on one as the other. But, as a rule, still, bright mornings are the most favorable; windy mornings, the least favorable for the bird-student.

This inexplicable diurnal variation, added to the luck of the chase and the difficulties presented by a forest environment, give endless interest to the pursuit of tropical birds. Although, with the excep-

tion of comparatively few migrants from the north, the avifauna is composed of permanent resident species, one may go over the same route day after day with the expectation that on each occasion he will add something to his knowledge of birds.

MIGRANTS FROM NORTH AMERICA

Twenty-six species of North American birds have been recorded from Barro Colorado as migrants—chiefly winter visitants. Twenty of these may be considered forest-inhabiting and no less than one-half this number are Warblers (*Mniotiltidæ*).

At this season all are songless and, beyond an occasional *chicky-tucky-tuck* from a Summer Tanager, one rarely hears them utter even a call-note. None is common enough to be much in evidence, Chestnut-sided Warblers being seen most frequently. They are in winter plumage until March, when the chestnut markings begin to appear on their satiny white underparts.

I have seen few evidences of actual migration. At 5.30 on the afternoon of March 23, 1927, I saw a loose company of about thirty Barn Swallows flying west across the lake at an average height of fifty feet. This species had not been observed before, and these birds were evidently north-bound migrants, although their course, following the land, was west.

On the preceding morning, as before recorded, thirty Kingbirds passed on their way to the United States; and they, too, flew west.

As Professor Baird long ago pointed out, nearly all migrant land-birds from the north that winter in South America come from eastern North America, while few migrants of the western United States winter south of Mexico and the contiguous parts of Central America.

A glance at a map will show that the birds of both areas are following the most natural routes southward. It will also show that only eastern birds are obliged to cross large bodies of water, and that, presumably, they are exposed to greater dangers during their semi-annual journeys than are migrants that always have land below them.

Warblers, Tanagers, and Flycatchers appear quite at home in their tropical haunts, but to meet a familiar species, like the Catbird or Wood Thrush, is like encountering an old friend far from home, and I feel that birds I know so well should also recognize me.

THE VERTICAL DISTRIBUTION OF FOREST BIRDS

Just as there is a marked stratification in the vegetation of the forest, so there is in the vertical distribution of forest birds. The forest floor, the tangle

of fallen tree-tops, and the dense, low growth of the borders and open spaces in the forest, an intermediate region including the lowest trees, and the forest roof—all have their characteristic birds. Between the two lower and the two upper habitats there is more or less exchange of life, *inter se*, but I should as soon expect to see a wild Parrot, for example, in the state of Connecticut as in the lower growth on Barro Colorado. Nevertheless, there is frequent invasion of the tree-top birds into the mid-forest zone for nesting as well as for food. The Trogons, particularly the Massena Trogon, are often seen feeding below the forest roof, and Gross found the last-named species nesting in a termites' nest less than eight feet from the ground.

The truly terrestrial birds include the Chestnut-headed Tinamou, Wood Quail, Wood Rail, Cassin's Dove and certain Antbirds,[1] which feed wholly, or nearly so, on the ground. But while one may draw a line between strictly terrestrial feeding birds and those that secure their food in the lower growth, the reverse is not true. It follows, therefore, that most of the species of the extreme lower growth and fallen tree-top tangles are often associated with those of the habitat below them. Examples are the Antbirds[2]

[1] *Formicarius analis, Myrmeciza longipes, Pittasoma michleri,* and *Sclerurus.*
[2] *Gymnopithys bicolor, Phœnostictus.*

that follow the army ants so closely one rarely sees them elsewhere, and other[1] members of this family more generally distributed in the forest. Here, too, should doubtless be placed the true forest Wrens,[2] and the singular Ant-Tanager[3] which probably feed on the ground more often than they do off it. Indeed, the only birds of the lower growth which appear not to leave it are the Spotted Antbird, the Tyrannine Antbird, and Blue Grosbeak. The two latter, however, are forest-border, rather than forest-interior birds. Even such active creatures as Hummingbirds have their place in the vertical distribution of forest bird-life. The members of the genera *Threnetes*, *Glaucis*, and *Phæthornis* feed largely from the blossoms of Heliconia, and live chiefly at the level of this plant. They belong in the second, or thicket zone.

By far the greatest number of birds, both in species and individuals, inhabit the wide zone between the denser undergrowth and the tree-tops. This is the home of most of the Antbirds,[4] the Woodcreepers,[5] and so-called Ovenbirds;[6] of a host of Flycatchers,[7] the Manakins,[8] Attila, and some Puffbirds.[9]

[1] *Myrmeciza exsul, Gymnocichla nudiceps, Hylopezus perspicillatus.* [2] *Henicorhina prostheleuca, Leucolepis phæocephalus.* [3] *Phœnicothrapis fuscicauda.*

[4] *Genera Cymbilaimus; Thamnophilus; Myrmotherula; Dysithamnus; Microrhopias.* [5] *Glyphorhynchus; Sittasomus; Dendrocincla; Xiphorhynchus; Lepidocolaptes; Dendrocolaptes.* [6] *Automolus; Xenops.* [7] *Placostomus; Craspedoprion; Rhynchocyclus; Oncostoma; Mionectes; Pipromorpha; Leptopogon; Tyranniscus; Onychorhynchus; Cnipodectes; Myiobius; Terenotriccus;* and others.

[8] *Pipra mentalis, Manacus vitellinus.* [9] *Malacoptila; Monasa; Nonnula.*

It is not until we reach the forest roof that we find birds which are popularly associated with the tropics. They include Parrots,[1] Toucans,[2] Trogons,[3] Hummingbirds,[4] Motmots,[5] Cotingas,[6] Honeycreepers,[7] Tanagers,[8] Vireos,[9] Warblers,[10] Oropéndolas,[11] Caciques,[12] as well as Guans,[13] Pigeons,[14] Puffbirds,[15] a few Flycatchers[16] and a Grosbeak.[17]

If we were considering the habitats of birds in relation to the nature of their food, we would observe that almost all the birds of lower distribution are insect-eaters while those of the tree-tops are for the greater part fruit-eaters and flower-feeders. Note, for example, how many more Flycatchers there are in the middle zone than in the tree-tops.

I have introduced this outline of the vertical distribution of forest birds on Barro Colorado to call attention to the relation which exists not alone between food and habitat but also between color and habitat.

THE COLORS OF TROPICAL FOREST BIRDS

If specimens of the birds mentioned above were placed in the order of their usual range above the ground, it would at once be observed that all the

[1] *Amazona, Pionus.* [2] *Ramphastos, Pteroglossus.* [3] *Trogon, Trogonurus, Curucujus.* [4] *Thalurania, Heliothryx, Florisuga, Anthracothorax,* and others. [5] *Baryphthengus, Electron.* [6] *Tityra, Erator, Lathria, Lipaugus, Cotinga, Querula.* [7] *Dacnis, Cyanerpes, Chlorophanes.* [8] *Tangara, Thraupis.* [9] *Vireolanius, Vireosylva.* [10] *Dendroica.* [11] *Zarhynchus.* [12] *Cacicus.* [13] *Penelope.* [14] *Columba.* [15] *Notharcus.* [16] *Legatus, Myiodynastes, Myiarchus.* [17] *Pitylus.*

more brightly colored species had, so to speak, risen to the top. There, as we have just seen, are the Parrots, Trogons, etc., while below are the Antbirds, Woodcreepers, and other species of dull and neutral tints. The Antbirds (*Formicariidæ*) and Woodcreepers (*Dendrocolaptidæ*), constituting two of the largest families of tropical American birds, contain over 800 species, not one of which is brightly colored, and all live in the lower zones.

We have found a single Tanager (*Phœnicothraupis*) living on and near the ground and two brightly colored Manakins in the middle zone. But the male Tanager's dusky markings suggest a quenched fire and the female is dull olive-brown, while the Manakins feed as frequently in the tree-tops as they do below them, and the females of both species are olive-green.

If we should extend this review in detail over the forest birds of tropical America, we should find this relation between color and habitat so constant and pronounced, we could not avoid believing that it possessed some significance.[1]

Usually it has been thought that this general resemblance between a bird and its immediate surroundings is for purposes of protection. I myself have supported this theory[2] and it has been generally

[1] The Pittas (Pittidæ) of the Old World present a marked exception.

[2] Birds of Trinidad, Bull. Amer. Mus. Nat. Hist., 1894, pp. 18–21.

accepted, but without due consideration of even a fraction of the facts and factors involved. For instance, it is true that the birds of the lower growth, the floor and interior of the forest, are inconspicuously colored, but it is not true that all the birds of the forest roof are brightly colored. There are, indeed, large numbers of dull-colored birds that live and feed in the tree-tops—Guans, Pigeons, Puffbirds, Lathrias, *Lipaugus*, and the Grosbeak, *Pitylus*—while some of the Cotingidæ[1] are white or nearly so, and the Oropéndolas and Caciques are largely black. In short, practically the whole range of color in birds is found in the tree-top group. Why are the Flycatchers of the forest interior largely dull green and olive in color while those that live in exposed, open places are notable in color, voice, and actions? The Derby, Boat-billed, Cayenne, Colombian, Lictor, and other comparatively large, noisy species with rich yellow underparts cannot be overlooked by the most unobservant; nevertheless, they seem to be successful species unhandicapped by their conspicuousness.

Why do the brightly colored Tanagers of the genus *Ramphocœlus* live in scrubby or scattered growth where their bright reds and yellows quickly attract attention? Why do the brilliant orange and black Orioles live among the scattered, thinly leafed trees

[1] *Tityra, Erator, Carpodectes.*

rather than in the denser growth of the forest roof? Why does the brilliantly colored Purple Gallinule expose himself in the glaring sunlight of lagoons?

The relation between color and habitat in these species would seem to support William Beebe's[1] suggestion that bright colors are associated with bright light and that consequently the most brilliantly colored birds inhabit the forest canopy where the studies of Allee[2] show that the average light intensity is twenty-five times greater than that in the shade on the ground.

But we have seen that many dull- as well as bright-plumaged birds live in the forest roof. Again, some of the most brilliantly colored species, the blue Cotingas, for example, have dull-colored mates. If light is the underlying cause in the development of bright colors should we not expect it to act on both sexes of a species and also on all, or nearly all, of the species exposed to it under essentially similar conditions? Furthermore, no birds are more exposed to light than those that inhabit plains and deserts; nevertheless, among these groups there is a pronounced absence of color.

It is, however, not inconceivable that the dull, dark colors of the birds of the lower growth and forest interior are produced by the excessive humidity of

[1] *Tropical Wild Life*, p. 88. [2] *Ecology*, VII, July, 1926.

their haunts. The effects of humidity in intcnsifying the colors of birds have becn long known. The wide-ranging North American Song Sparrow is a classic illustration of this type of response to environmental influences, the differences, for example, between the colors of the pale, sandy Song Sparrow of the arid Colorado Desert and those of the sooty Song Sparrow of the humid Alaskan coast being as pronounced as the climatic differences between the regions in which the birds live.

The colors of the Ant-Tanager, already referred to, are of the "saturated" type which characterizes the plumage of many birds inhabiting humid areas. It requires, in fact, but little imagination to see in this species a once red bird the colors of which have been darkened by residence in an excessively humid habitat.

Comparison of the colors of those birds living on or near the ground with those of the mid-forest zone shows greater intensity of coloration in both sexes of the lower ranging species where the humidity is highest. The deep tones of the Antbirds, *Formicarius analis* and *Myrmeciza exsul*, for example, are pronounced examples of saturation. Thus, these birds living on or near the forest floor appear to demonstrate, locally, a law that has long been accepted in its wider applications.

Are these conditions the results of physiological reaction to environmental influences, light or humidity, and without biological significance? In other words are bright colors lacking among the lower ranging birds because the humidity of their haunts suppresses them and are they present in tree-top birds because this controlling influence is removed? We have seen that birds of any color may live in the tree-tops. Could the same thing be said of the lower growth? In short, is there protective coloration among the birds of a tropical forest? Before attempting to answer this question, let us ask another. Is there *need* for protection among the birds of a tropical forest? In other words, what are the enemies of tropical birds?

It is a singular coincidence, but quite typical of a naturalist's life on Barro Colorado, that at this point, tempted by the beauty of the day and the call of a Motmot, I left my desk for the forest. The Motmot, certainly protected by his colors from my eyes, ceased his call and was invisible. Silently I waited for his voice, meanwhile scanning the trees for a flick of his tail, when, with no apparent cause, a Chestnut-headed Tinamou flushed from the forest floor fully fifty feet or more away. If I had startled the bird it assuredly showed small faith in the protective value of its coloration. But scarce had the whistle of its wings ceased when, with a rustle of

footsteps on dried leaves, a Tayra entered the trail from near the spot whence the Tinamou had flown. At sight of me it ran quickly up a good-sized tree, crossed through its top to another, and disappeared. It was he, not I, that had alarmed the bird. The Tinamou could have been only a few yards, perhaps a few feet, from the Tayra when it sprang into the air. Did it owe its life to its olive, brown, and black-flecked back, its lighter underparts? Was the Tayra hunting it by sight or scent? If the bird had been conspicuously colored could the beast have made his final rush from a greater distance? Here, indeed, was a problem in the relation of a bird's colors to its habitat at my very doorstep. Whatever the answer, there can be no doubt that the Tayra should be ranked among the enemies of tropical birds, and with it we may head a list of their foes. Among mammals may be added the Grison, Opossums, Coatis, Skunks, Ocelots, Yagouarondi, Puma, and Monkeys. Reptiles include snakcs, alligators, crocodiles, and turtles. Bird-foes, aside from parasitic species, are doubtless restricted to Hawks and Owls. The list seems formidable, but let us examine the animals named from our somewhat restricted point of view; that is, as they threaten the adult bird.

Every bird-student knows that the time of highest mortality among birds is while as eggs or young birds

they are still in the nest. For example, during my close watch of the Oropéndolas for three nesting seasons, a period in their year when the adults are more than usually subject to attack, only one adult was known to have been killed at the nest-tree. The excitement aroused by this tragedy was still evident the following day, and it seems fairly certain that it was the only incident of the kind that occurred during the approximately eight months the birds were under observation.

But in spite of the fact that their nests are closed and comparatively difficult of access, there was high nest-mortality. Its causes are related in the chapter devoted to that species. In one season they led to the abandonment of the colony before an egg was hatched.

The Cotinga breeding in the same tree lost her nest and its contents on two successive years, but the bird herself was apparently unharmed. Evidence of this kind might be cited indefinitely, for wherever the nesting-habits of birds have been studied intensively a high percentage of destruction to eggs and young has almost invariably been discovered.

When, therefore, we examine our list of bird enemies (and we are giving no consideration to body parasites) we find that the larger number are more harmful to eggs and nestlings than to adult birds. Opossums and the smaller cats are in part, and

monkeys are wholly tree-feeders. They rob birds' nests but it is difficult to believe that they often catch mature birds. The shaking of the limbs as they climb about would be apt to alarm their prey. Furthermore, with the exception of Monkeys, they all feed at dusk or after when, in any event, colors, at least as we see them, have no special significance.

Of the Grison's habits I know nothing, and it is too rare an animal to be of much importance as a bird enemy. The Tayra, Coati, and Skunk hunt on the ground, and the first two are also arboreal. They hunt by night as well as by day and may be reckoned among the worst enemies of birds, but are doubtless more destructive to the nest and its contents than to birds at large. Snakes also share this reputation, and the three remaining reptiles are only locally dangerous.

Of the feathered enemies of the adult bird, Owls are nocturnal. If we may judge by Dr. A. A. Allen's studies of the Screech Owl[1] at Ithaca, N. Y., their ability to see when diurnal birds can probably distinguish but little, if anything, places the latter at their mercy without regard to color.

Summarizing this very brief and superficial review, I believe that the chief enemies of adult birds are terrestrial mammalia, Hawks, and Owls. These are

[1] *The Auk*, 1924, pp. 1–16.

accountable for the death of countless individual birds and still the species they represent survive. What are the factors that in the long run enable them to hold their own? I should name them in the order of their relative importance as (1) Habit; (2) Habitat; (3) Color.

Habit includes adaptability to the demands of both habitat and color. A Flamingo's habitat and its color make it one of the most conspicuous of birds. It is protected chiefly by its wary habits. Habitat offers widely varying degrees of exposure or of protection. Terrestrial species are doubtless more exposed to danger than arboreal ones; oceanic islands are safer than continental areas; beach-inhabiting birds are more subject to attack than those that live in marshes. In color a species may more or less closely resemble its surroundings or it may be in strong contrast to them. In either event, it is habit, not color, which decides its fate. Movement without regard to color reveals, and it is the habit of protectively colored birds to squat or hide; while conspicuously colored ones seek safety in flight.

The comparative value of these three factors must be learned from a study of a bird's habits, its habitat, and its colors in just such an undisturbed environment as Barro Colorado offers. Birds are by no means automatons. They show wide variation in

habit; within certain limits they select their habitat, and they seem aware of the degree to which they can depend on their color for protection.

Let me illustrate these points from my studies of the Oropéndola, the only bird on Barro Colorado that I know much about. Note, in the first place, that the birds lived in constant expectation of attack from the air. Hawks, evidently, were the only enemies they feared. What measures did they take to escape them? Primarily, they depended on their alertness. They were constantly on guard. Whenever a Hawk passed near the nest-tree they sounded their alarm. This was habit. The response to it was immediate and unquestioned; it was obeyed even by other species and at once the birds dived into the dense growth below the nest-tree. In leaving an exposed position for a secluded one they displayed an appreciation of the protective value of habitat. At the same time they showed entire lack of confidence in the value of their color to protect them. From our point of view the Oropéndolas are conspicuously colored. They evidently agree with us. They make no effort to hide in the presence of real or fancied danger. When the alarm is sounded their immediate reaction is to seek the nearest cover. They place no dependence on their color. Factor No. 1 is their strong point.

Let us turn now to Parrots, also tree-top birds. I speak of them with some hesitation for I am not sufficiently familiar with the habits of these birds to have much confidence in my fitness to explain the inter-relations of their habit, habitat, and color, but at least I may open the discussion.

No birds of the tree-tops more nearly resemble their leafy surroundings than do Parrots. Every bird-student in the tropics knows how difficult it is to see a Parrot or a flock of Parrots, even when the foliage among which they are perching is comparatively open. The birds, perhaps calling loudly, fly into a tree-top, become silent and motionless, and, at the same moment, disappear. Even the large Amazonas seem in some mysterious manner to melt into their surroundings. The food they came for may be within their reach but they do not venture to take it until they seem assured of the safety of their surroundings. Then they move about freely and talk loudly, and the moment that they move they become visible. If from below I alarm them, they do not attempt to hide in the leaves they so closely resemble in color; they seek safety in flight, screaming as they go. They apparently, therefore, rely on their alertness rather than on their color to escape from danger.

When Parrots alight in dead, leafless trees, as they

often do, their surroundings are open and appear to arouse no suspicion. Nor do they seem to be concerned by their conspicuousness when perched on a bare limb in bright sunlight. But always they are wary and ready to take alarm.

Size, color, voice, actions, combine to place Toucans among the most conspicuous birds of American tropical forests. Their abundance and wide distribution mark them as a successful group. After an intensive study of Toucans on Barro Colorado, Dr. Josselyn Van Tyne writes of their colors:[1] "I should not wish to state dogmatically that there is no such thing as protective coloration among Toucans, but, after nearly a year of field experience with this[2] and two other species in Panama, I feel sure that it is of very slight importance. It is quite true that in many situations in a tropical jungle, if a Toucan *does* sit quietly, the yellow throat and bill stand out alone and readily pass for a yellow fruit or leaf. But the actions of a Toucan usually defeat any effect of protective coloration. At the first sign of danger, the Toucan almost invariably begins to bob about on its perch and croak loudly, advertising its presence to all within a half-mile or more.

"I would summarize my conclusions thus: the Toucan is not as conspicuous in the tropical jungle

[1] Univ. Mich. Misc. Pub., No. 19, 1929, p. 37. [2] *Ramphastos brevicarinatus.*

as one familiar only with northern birds might suppose, but, on the other hand, it seems extremely doubtful whether protective coloration has any real significance in the life of this species."

For contrast with these representative arboreal species, let us now descend to the ground and observe the actions of terrestrial birds. The Chestnut-headed Tinamou is an excellent example of what, from our point of view, is a protectively colored species. We have seen it wait until the Tayra was near it before it sprang into the air. I rarely cross the island without repeating the Tayra's experience. Wood Quail act in a similar manner, but it is to be noted that both these birds roost in trees. The Antbirds[1] and Wood Wrens[2] appear to show confidence in the protective value of their colors and are notably tame.

Extending our field for a moment, the Quail, Grouse, or Woodcock that "lie to a dog," the Whip-poor-will and Parauque that jump from the leaves at your feet—all show, in their actions, belief in their comparative invisibility. It is no doubt true that, to some extent, these birds are hiding and depending on the concealment which may be afforded by their immediate surroundings as well as on their colors to escape observation. Place them in an exposed situa-

[1] *Formicarius analis; Myrmeciza exsul.* [2] *Henicorhina; Leucolepis.*

tion and they become comparatively wild. But against their own background, even when wholly visible, they often permit one to approach within arm's length. The Grouse on her nest at your feet, the sitting Woodcock that permits you to touch her, are good illustrations. Or, since the fever of incubation doubtless plays a part here, the Whip-poor-will and Parauque that rest on the leaves and fly up before you, to drop to earth a few yards beyond, disappearing as they alight, are as admirable examples of protective coloration, and an appreciation of it, as can be found among birds.

Compare the actions of these birds with those of the Purple Gallinule already described, and we have an excellent illustration of the wholly different actions of protectively, and conspicuously colored terrestrial birds under normal habitat conditions.

Clearly, then, the case of protective coloration cannot be tried without taking testimony from the birds, and, until the evidence is all in, no decision can be considered satisfactory. If, however, I should venture to offer a provisional opinion based on the evidence herewith presented, I should say that on and near the ground, where the character of the environment and exposure to attack make their strongest call for a harmony in color between a bird and its surroundings, there protective coloration has

been most highly developed and the birds, apparently aware of its value, in varying degrees depend upon it to escape detection. But in the forest roof where there is presumably less danger, and where the character of the environment is so varied that close resemblance between it and its bird inhabitants is neither possible nor necessary, there protective coloration has not been developed and the bird relies chiefly on its alertness for safety.

I once saw a male Blue Honeycreeper on the forest floor to which it had descended to feed on fallen fruit. The bird's bright colors made it so strikingly conspicuous against a dark background of earth and dead leaves that if a Coati, for example, has eyesight anything like mine, the bird would have been a shining mark for him, just as a pet Tovi Paroquet, whose swinging perch was placed too low, was captured by one of these animals a few days ago outside the laboratory door. In the tree-tops both the Honeycreeper and the most protectively colored terrestrial bird would have been inconspicuous.

If, then, we accept as a working hypothesis the theory that the birds of the forest floor are protectively colored, while those of the forest roof are not so colored, to what influences may we attribute the development and existence of these conditions?

Are we to believe that the dull colors of the birds

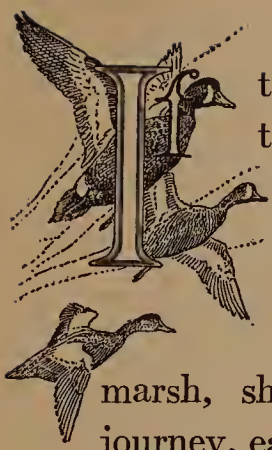
of the lower growth are due only to the effects of humidity, and hence to the direct, automatic action of environment? Or, if this environmental influence is not universally potent, and, in spite of it, bright colors do appear, what force suppresses them? If such a force be needed, and I am by no means sure that it is, I should invoke natural rejection rather than natural selection. The fit appear, through whatever influences, and because they are fit are permitted to remain; the unfit appear, and because they are unfit are rejected. In the first case, environment, represented by the bird's enemies, is passive—it neither selects nor rejects; in the second, acting through the same agents, it is active—it rejects.

Ascending to the mid-forest area, we reach a zone of less danger and there is a wider variety of color—more olive-greens, grays, and lighter browns. Here are the dull-colored Antbirds and Flycatchers, the Woodcreepers of many species, all of which, without exception, are neutral brown, usually broken by whitish streaks. Here the fitly colored bird takes his place, but the law of rejection is less rigidly enforced and brightly colored birds of the forest roof—Trogons, Motmots, and Toucans—feed in the lower tree-tops. Thus we reach the forest roof with its riotous wealth of foliage, its infinite variety of form and color in leaf and blossom, its dazzling lights and

deep shadows. Here, in the colors of birds, also, we seem to leave all law and order. The most brilliant and the dullest plumaged birds live side by side, perhaps even as mates. Where are the forces of natural selection or rejection? So far as protective coloration is concerned, their occupation is gone, there is no need for them. Here is a habitat in which no one thing is conspicuous because so many things are conspicuous. Here is an environment where cover and concealment are always within a flit of the wing. Here the bars are down and nature may express herself without penalty. And here, for the present, I leave a problem about which we actually know so little that our best attempts to solve it are based largely on mere theories. The answer is to be found in the forests of Barro Colorado. Let us seek it there.

CHAPTER XIV

OFF THE ISLAND



If the ornithologist on Barro Colorado wishes to widen his experience, he has only to cross to the opposite mainland to find birds as yet unknown on the island. Thence he may extend his travels indefinitely and discover that savanna, marsh, shore, and islet, all within half-a-day's journey, each has its distinctive species. But Barro Colorado is a difficult place to leave, and my plans to see more of the bird-life of Panama have taken me only to the Pacora marshes and, incidentally, Ancon Hill and its environs. The former is a rich field for the bird-student. The latter is not exactly the place one would select for ornithological exploration, but as the residential center of Americans at the Pacific end of the Canal Zone, its birds may be more intimately associated with man than those of the forest primeval, and they thus form an asset which I attempt, at least casually, to appraise.

The Pacora Marshes

If there be a finer lot of men anywhere than the "Old Timers" of the Canal Zone, I have still to meet

them. No naturalist could ask for more convincing evidence of the effects of environment than they afford. They have had a part in one of man's greatest achievements, and there has developed from this association a quiet personal dignity and a certain unassuming assurance which is the just possession of men who have been tried and not found wanting. I recall one who was demonstrating to guests of the Canal, with whose high rank and honored names he was wholly familiar, the details of passing a ship through a lock. Needless to say, he was master of every move required and of the machinery that controlled it; but not for a second did he realize that in the simplicity and naturalness of his bearing even more than in the grasp of his job he was the most impressive part of the exhibition.

Another I have in mind has been in the Zone a quarter of a century. Neither in body nor in mind does he show the effects of long-continued residence in the tropics. He came here a keen hunter and a keen hunter he remains. No difficulty imposed by marsh or mountain restrains him; and always he shows a consideration for the failings as well as the rights of his fellow huntsman, which is not too common among sportsmen in the field. Whether this trait be wholly inherent or is in part the acquirement of the "Old Timer" I do not pretend to say, but I

strongly suspect that the influences of the Zone had excellent material to work on! To this gentleman I am indebted for the opportunity, in January, 1929, of making a reconnaissance, the principal results of which are herewith recorded.

The region known under the general name of Pacora Marshes was selected for this little expedition, not only because it offered a wide variety of habitats but also because the bungalow of a hunting club afforded a home where, as on Barro Colorado, one could live twenty-four hours a day in the heart of his territory. Situated on an arm of the savanna, which projects slightly into the marsh, the site of this comfortable little dwelling is indeed even better suited to the wants of the ornithologist than to those of the sportsman. The marsh lies fifteen to twenty feet below the level of the savanna and was possibly an estuary, for we are here only two miles from the Pacific. On the slopes and at the foot of the bank or bluff where savanna passes into marsh, there is a narrow fringe of forest nourished evidently by seepage and the small streams which at intervals trickle out from the base of the bluff. Thus in a cross section of less than one hundred yards one encounters three distinct types of ground, each sharply defined from the other. It is unnecessary to tell the bird-student that the ranges of the birds characterizing each of

these habitats are as sharply defined as the habitats themselves. The savanna birds stopped at the border of the woods; the wood birds were confined to their narrow strip of trees and undergrowth; and immediately beyond were the birds of the marsh and its lagoons. The whole made an admirable illustration of close relation between haunt and habit and its influence on local distribution. But the same factors must be taken into consideration in studying the distribution of bird-life in its larger aspects. It is the non-specialized species that defy these local boundaries and, as a rule, are wide-ranging.

In the heart of the savanna, a King Vulture, surrounded by a cordon of humble, waiting Caracaras, Black Vultures, and Turkey Buzzards, was feasting on the carcass of a cow. The whole carrion-feeding crew would have been equally at home if the cow had died in the woods or been mired in the marsh.

The Pacora Marsh is about thirty miles east of Panama City. The first twenty-four miles are over an excellent road which, after leaving the outskirts of Panama, crosses a number of attractive forest-bordered streams. The remaining six miles are over the savanna where a chart of the vertical course of our automobile would resemble the record of a seismograph after a violent earthquake. We escaped with a broken spring.

Barely had we left the road when we flushed several Panama Meadowlarks, so closely resembling the bird of the eastern United States that to the layman they are the same species. He makes the mistake, however, of thinking that the northern bird has come here, whereas the Meadowlark, with a range extending to northern Brazil, may truly be called a tropical species of which our bird is a Temperate Zone representative.

Young birds in nestling plumage were on the wing; the adults were still in worn breeding dress and it was evident that the nesting season was just over. The few songs I heard were composed of only three or four notes, in form like those of our eastern bird but in tone with a suggestion of the Western Meadowlark's song. Unfortunately, I heard no call-note.

With the Meadowlarks were numbers of so-called Red-breasted Meadowlarks,[1] of northern South America and north to western Panama, and these two birds, with a Marsh Hawk, were the characteristic species of the savannas; one might better say prairies, for this beautiful, rolling, cattle-dotted country has a breadth and sweep one does not associate with the term savanna.

I had anticipated devoting my time chiefly to the marshes, but the woods held so large a number of

[1] *Leistes militaris.*

birds that it was difficult to leave them. Though less than seventy yards in width, they bordered the marshes and penetrated the barrancas for miles. Thus they drew their life from a wide area and compressed it in a narrow one. The trees, as a rule, were not high, the abundant undergrowth was easily penetrated on cattle-trails; the conditions, therefore, were as favorable for the bird-student as for the birds. After the tall trees and dense growth of Barro Colorado, it was a relief to look into a tree-top with some hope of identifying its birds and to follow a bird-song with a fair prospect of seeing its author. In fact, one was embarrassed by an abundance of riches. If there had been fewer birds I should doubtless have seen more. I do not recall any other woodland where birds were so abundant and so easily observed. A census-maker would have been in his element, and a collector might have secured more specimens in an hour or two than he could have preserved in the remainder of the day. But I was making neither a list nor a collection of birds. It was the identification of their notes to which I chiefly devoted my attention. Aside from its obvious value in their future naming, this is a phase of bird-study which often has a bearing on relationships. The Meadowlark, to which I have already referred, is a case in point, and at Pacora, for the first time, I

learned satisfactorily the notes of the Groove-billed Ani. The bird so closely resembles the Common Ani that the two cannot be readily distinguished in nature, but their notes are surprisingly unlike. In place of the loud, complaining, long-drawn *oo-eek, oo-e-e-k* of the Common Ani, the Groove-billed species uttered rapidly a high, thin *plee-ee, plee-ee, plee-ee* and a guttural chuckling. One familiar with their notes could never mistake the two birds which, judged by the difference in their voices, are apparently much less closely related than their appearance indicates. Furthermore, one establishes associations with a bird through its calls that cannot be formed in any other way. If this is true for the local student, how much more strongly does it apply to one who meets the same species in a hundred different places and everywhere recognizes its voice as that of an old friend.

I had not been many minutes at Pacora before I heard the call of the Laughing Hawk.[1] At once it carried me back to Chichenitza, in Yucatan, where, thirty-odd years ago, I first heard it call from the ruins, and could almost persuade myself that it was the voice of a departed Mayan. "*Oh hark! Oh hark! Oh hark!*" it cried with increasing emphasis and earnestness, then laughed a mirthless, maniacal "*hah-*

[1] *Herpetotheres cachinans.*

hah-hah." Its voice has an uncanny human quality and it possesses an apparently unlimited variety of notes. At times it perched in a large bombax near the house and at the edge of the marsh, crying softly, as though to itself, for an hour or more without ceasing. A strange character is the Laughing Hawk with his strongly marked features.

I had arrived during the silent mid-day period and it was not until evening that birds began to announce their presence. Then from the woods came the persuasive, sonorous cooing of Doves, the emphatic booming of Pigeons, the plaintive trill of the Pileated Tinamou, the chatter of Tovi Paroquets and excited twittering of Flycatchers. As the light failed, Parauque Goatsuckers called from a dozen places, and at nightfall the marsh became vocal with the loud, weird calls of Rails and Gallinules and the hoarse squawks and croaks of Herons.

It was not until early morning that the bird-life of the place was more fully revealed. The broad cattle-trails created almost park-like vistas through the bordering strip of forest and, with little or no obstruction, one could follow a voice or gain a definite view of the inhabitants of thickets or tree-tops. At intervals Parauques arose softly, silently, and, although in full sight, they disappeared as they alighted.

Flycatchers probably furnished the greatest variety of notes, and ten species were observed. Antbirds were correspondingly rare, and only the Fasciated and Black-crested Antshrikes were seen. The absence of such true humid-forest species as the Chestnut-headed Tinamou, Panama Antthrush, Sclater's and McLeannan's Antthrushes, Fruit Crows, Wood Wren, and many others, created a marked difference between the bird-life of the Pacora and Barro Colorado woodlands. The former, however, were not without such true forest birds as Toucans, Parrots, and Trogons, and I saw several Squirrel Monkeys.

Attila represented the Cotingas, and the Sharp-tailed Manakin, the Manakins. The latter is found only in the more open growths of the Pacific side, and I had considered the former equally characteristic of dense, humid forests; but its measured, emphatic *beat-it, beat-it, beat-it, no-ó-w* was one of the common bird-notes at Pacora. An additional call, which I had never before identified, was a sharp twitter as it made short flights revealing its yellow rump. It perched, at times, within a few feet of the ground, sitting erect and alert, frequently lifting its tail with a phœbe-like motion and nervously flitting its wings.

The Panama Robin was evidently approaching its

breeding season, but even a few bars of its song were strongly suggestive of that of our northern bird. Other reminders of distant scenes were a Summer Tanager, Black and White and Prothonotary Warblers.

In appearance and notes, Wagler's Woodpecker is enough like our Red-bellied Woodpecker of the same genus also to seem familiar. The nesting season of these birds was obviously at hand. Noisily they chased one another through the branches of a large tree, ignoring a Large-billed Hawk, who seemed equally uninterested in them. Perhaps he, too, was voicing the sentiments of the season, as with a loud *wack, wack, wack kié* he replied to one of his kind nearby.

A Cacique gurgled and whistled from a tall bombax but his calls brought no response, and I saw no colonies of these birds or any of their allies.

Lawrence's Woodcreeper, the commonest member of its group, found alike in dense forests and open growths, was the only species of its family identified. Of Tanagers the Blue, and Crimson-backed, and White-shouldered; and of Finches only the Streaked Saltator were observed. Of these only the latter may claim to rank as a songster. I should have seen at least half a dozen additional members of this family.

True to its singular liking for human habitations,

a Panama House Wren had made our little bungalow its home. Build a house almost anywhere from Patagonia to Canada and a House Wren appears. Build a Wren-house and he takes possession of it. The uninhabited forests of southern Chile is the only place away from the haunts of man that I have ever found the House Wren common.

From the lower growth at the border of the woods there came a great variety of ringing whistles from Galbraith's Wren. Its songs resemble in character those of our Carolina Wren, but the bird has a wider repertoire, and also the habit shared by other tropical Wrens of antiphonal singing. So closely do the notes of the second Wren follow those of the first that only when I chanced to stand between the performers did I discover that two birds were singing. The entire song was composed of four notes of which each bird uttered two. It was given rapidly, snappily, and the parts were joined with such absolute precision that the birds seemed animated by a common impulse.

But all these songs and calls sank to insignificance before one of the most arresting performances that I have ever heard from the throat of a bird. It was not its volume that commanded one's attention. It was not a loud song; the tone, indeed, was a low contralto; but so full-throated, so mellow, so rich, and

the song itself was of such marked musical distinction and executed so flawlessly that it completely dominated one's senses; to see the singer became my only object in life.

It bore no close resemblance to the song of any bird with which I was familiar. There was, therefore, no clue to the identity of the singer through its relationships. The bird was apparently in low growth. For an hour or more I vainly watched and listened. Then the marvelous notes, thrilling as when first I heard them, came from another locality. Evidently the bird was moving. I blessed the cattle-trails and hurried after it. Again a long wait, then a repetition of the song from undergrowth quite near me, and to my surprise I discovered that its author was a Wren. In books its dried skin has been named Chestnut-backed Wren; only a poet-musician could name the living, singing bird. In general appearance and structure it does not differ markedly from Galbraith's Wren, belongs indeed to the same genus, but the

Chestnut-backed Wren

songs of the birds are as unlike as the notes of banjo and cello. As in the case of the two Anis, it is probable that our classification suggests a closer relationship between these two Wrens than actually exists.

I shall not attempt to describe the song of this Wren. The bird was not nesting and evidently not in full voice. Mrs. Sturgis, who was the first author to pay tribute to its vocal gifts, writes[1] that one lived on Ancon Hill for three years and, in addition to the notes that I heard, she states that it has "a melodious song somewhat resembling a subdued bugle-call."

There remained the marsh. In the wet season it is largely under water. Now it was seamed and etched with shallow lagoons more or less covered with aquatic plants, including a blossoming white pond-lily, while the intervening muddy areas were green with fresh vegetation, of which a white pickerel-weed-like flower[2] was the most conspicuous.

Between woods and marsh there was no intermediate area. Two steps from the forest Wilson's Snipe flushed with its familiar *scaip*, to dart away in that zig-zag flight which sportsmen, with the characteristic assumption of mankind, think is especially designed for their confusion. In more open places there were occasional Solitary Sandpipers and

[1] Field Book of Birds of the Panama Canal Zone, p. 358.
[2] *Helianthera reniformis.*

they, too, though they cannot claim the distinction of being game-birds and hence have escaped the attention of man, flushed with erratic flight. Other visiting Limicolæ from the north were Semipalmated Sandpipers, an occasional Lesser Yellowlegs, and a single Killdeer.[1]

The lagoons with their lily-pads were the playground of many Jacanas—adults in their maroon or black plumage, immature birds olive-gray above and white below. There is always an air of light-hearted gaiety in the actions of these birds as they chase one another about like a lot of children at a game of tag; and the dainty grace of their movements as, supported by their ski-like toes, they step lightly over barely visible floating leaves and hold their wings aloft when alighting, adds to their attractiveness. About the borders of the lagoons and in the wetter parts of the marsh were many Little Blue Herons in the white plumage of immaturity (I saw only one adult) and, named in the order of their relative abundance, American Egrets, Great Blue Herons, a Bittern which I assume was Cabanis', Black-crowned Night Herons, Louisiana Herons, and Little Gray (or Green) Herons.

Wood Ibises with outstretched necks and black-tipped wings were not uncommon, and both the White Ibis and Roseate Spoonbill occur here, though

[1] No specimens taken and I cannot, therefore, name the form.

I did not see them. One morning a King Vulture, surrounded by circling Turkey Buzzards and Black Vultures, sailed overhead. Possibly this was the bird I had seen on the savanna.

My special objective in the marsh was distant a mile or more. To reach it I crossed the marsh facing the camp, passed through a narrow belt of gallery forest, and forded a river beyond which lay a second marsh where in the lagoons there were said to be large numbers of birds, including great flocks of Blue-winged Teal and Wichitys, or Black-bellied Tree Ducks. As guides for this trip and bearers of my large binoculars and cameras I employed two Negro boys. Their choice of route seemed to be governed by lines of least resistance and, without regard to the points of compass, they steered a course which led through the least mud and water and offered the smallest probability of encounter with crocodiles. For these animals they had a very genuine fear which was shared by my small but useful pony. A medium-sized Crocodile, which slid from the bank at a proposed ford, led to the selection of another crossing a hundred feet or more away. The boys went through in water to their waists, splashing vigorously; the pony, previously a placid animal, followed plunging wildly and snorting excitedly. At the border of the woods we left the pony and crossed the river

(the Jagua), here very narrow, but rather deep. Less than 200 yards beyond, several hundred Wichitys, whistling their name like a flock of Redwings in the spring, swung over and coursed about the marsh in search of a resting-place they evidently found difficult to select. With change of light and position they showed now their dark bodies, now their light wing-lining, or again their white wing-coverts flashed intermittently against their gray sides. Meanwhile the Teal had been discovered across the marsh.

I had a gun, and my guides, knowing only one kind of hunter, were now all animation. I sympathized with their surprise and disgust when, leaving the gun with them, I took my binoculars and camera and crept across the marsh for a nearer view and possible photograph. It was 9 o'clock; the birds had ceased feeding and were resting on the bare, muddy banks of the estero. Facing the wind, heads nestled between shoulders, breast to tail, they were massed in solid beds. Only through my powerful glass mounted on a tripod could I distinguish the outlines of individual birds. Repeated hundreds of times the whole made a duck mosaic of which each piece was the exact duplicate of the next. When I attempted to stalk them with a camera, they took wing long before I came in range, and I could capture a view of only a portion of the flock as it swept by.

The puzzled boys continued to watch me without understanding, and the statement that I had "many Ducks in my black box" did not seem to clarify the situation. It was their first experience with a bird-student, but if ornithologists do justice to the opportunities offered by the Pacora Marsh and the Old Timer, they should meet many more.

Ancon Hill

What happens in Panama when the forest disappears and dwellings surrounded by lawns and shade trees take its place? What are the Robin, Wren, Catbird and Thrasher, Downy Woodpecker, Nuthatch and Chickadee of a Panama garden? To be more definite, what birds patronize the feeding-tables and bathing-pools about the homes on Ancon Hill?

Both science and sentiment prompt the inquiry. On the one hand, birds deprived of a primeval environment must adapt themselves to new conditions; on the other, bird-lovers moving to new surroundings must find new friends to replace old ones. It is a novel experience for them both. Thus, when the North American bird-lover goes to serve his country in the Zone, the forming of a new circle of bird friends is not the least of the strange experiences he anticipates with interest. It is not probable that his

Blue-winged Teal at Pacora

The Pacora Marshes

A bit of savanna appears in the right foreground, the "gallery" forest borders it, the marsh lies beyond

Where Martins Roost

A scene in Panama City, near the Presidencia, just after sunset

The Savanna of Panama

A scene at Pacora

lot will fall on a Barro Colorado. Man in the bulk is on no better terms with nature primeval in the south than he is in the north. Pavements and plumbing and a humid tropical forest are among the things that cannot occupy the same place at the same time. But assuredly the combined efforts of the engineer, landscapist, and horticulturist have produced rarely beautiful home-sites on the steep, unpromising slopes of Ancon Hill. We are too apt to overlook their significance.

The miracle of canal construction has eclipsed the marvel of Canal Zone settlement and maintenance. The former was a feat in engineering; the latter daily presents human problems the terms of which go far beyond the limits of the locks. To transport a populace of over 7,000 men, women, and children from the North Temperate to the Tropical Zone and provide them with healthful, congenial surroundings for the needs of the body and wants of the mind develops as wide a variety of demands as life itself.

All of which diverts us for a moment from our consideration of the feathered citizens of Ancon Hill. And it should divert us. Even the birds of Barro Colorado seem no better suited to their haunts than the North American to his home in the Zone. Where are all the bugaboos of the tropics? The heat, the noxious insects, the disease, the loss of energy, the

mental depression, the generally restricted life? Ask the baseball players in the crowd-surrounded parks, stop at the tennis-courts, watch the football games, see the golfers on their emerald greens and fairways, or the bathers in pool or surf. Where will you find a community which gives greater evidence of enjoying that physical well-being which both prompts outdoor life and is the product of it?

But if, in those portions of the Canal Zone which man has made peculiarly his own, a bird-lover's enthusiastic approval of the result prevents him from sticking closely to his text, it will not be for lack of illustrations. One cannot go far along the winding hillside roads, over the green lawns, and beneath the endless variety of trees without observing that many birds have accepted these surroundings for the ones that have been displaced. Especially do they actively welcome the local showers provided by sprinklers and fountains which, marvelously enough, fall daily throughout the once dry season.

In less than an hour, late one March afternoon, in the very heart of Ancon, I saw seventeen species of birds visit a modest shower-bath tastefully set in vegetation. Flycatchers were in the lead; few gatherings of tropical land-birds are without a large representation from the over 400 species which compose this distinctly American family. There were two

species of Elænias, a Lichtenstein's Kingbird, several Colombian Flycatchers, a pair of Northern Todys whose long, pendent nest was nearby, and a Great-crest resembling ours. Even more familiar were several Panama Robins, House Wrens, and Yellow-

A Male Black-crested Antshrike and His Red-brown Mate

green Vireos, while a wintering Yellow Warbler may have been from my own northern home. Blue, Crimson-backed, and Palm Tanagers, a striped Saltator, Hicks' Seed-eaters, and Blue-black Grassquits all struck a more foreign note, and a male Black-crested Antshrike, with crest erect, slinking through the lower growth seemed too unlike his red-brown mate to be even distantly related to her. The Robins took

a good, hearty, all-over splash, but most of the others swung daintily to and fro beneath the tiny shower and through the dripping, sunlit leaves like animated flowers.

When the sun, which has surprised us by rising from behind the Pacific, sinks into the forested ranges toward the Caribbean, one should go out beyond Amador. There he may see the whole panorama of white-capped waters set with islands large and small, and encircled by a varied shore-line that rises from savannas through foothills to mountains hung with gorgeously illuminated clouds. In all the harbors of South America only that of Rio is more beautiful than the Bay of Panama.

Brown Pelicans are now catching their evening meal and plunge with a splash into the water at your feet, while Laughing Gulls hang overhead, waiting an opportunity to alight on the diver's head and pick his pouch of whatever he may have captured. Then the uncomplaining Pelican stolidly makes another cast into the bay whose name promises good fishing. Man-o'-War Birds, supreme masters of the air, circling easily overhead, only rarely reveal their powers as aërial gymnasts, and long, wavy, snake-like lines of Cormorants fly low over the water toward their roost on some rocky islet. Life and light disappear almost together and suddenly the night falls.

With one's memory still possessed by the beauty and romance of this tropic scene, it seems strange to be awakened by the songs of Robins. But as I have before said, while the Panama Robin has a more musical voice than ours, only an experienced, critical ear would detect a difference in their songs. So far as the Dawn Chorus is concerned, therefore, it might be cherry-time in New Jersey, and, when the Panama House Wren and Yellow-green Vireo join the day-break choir, it is easier to believe that you are in the Temperate rather than in the Tropic Zone. It needs the shrill twitter of Paroquets, the piercing pipe of Grackles, the dry roll of Antbirds, the whistles of Saltators, and booming of Verreaux's Doves to recall you to your real surroundings.

As midday approaches, the only birds in evidence are the Black Vultures and Turkey Buzzards that by hundreds circle over Ancon Hill. Here, evidently resting on the air-current that, deflected from its slopes, rises above the hill, the birds seem supported as by a cushion and with a minimum of effort wheel lazily in their aërial siesta. A far less pleasing side of their lives is revealed if we follow them to the market by the water-side, but the trip is worth while for the close views we may have of Brown Pelicans and Man-o'-War Birds. Nearby, just after sunset, we may see the Gray-breasted Martins drop down by

thousands to roost on the telephone wires. For a brief period, as they come flying in from every side and concentrate toward their dormitory, a veritable storm of birds occupies the air above the water-front. It is a scene of exciting confusion. But with soft chirps each bird seems to find its place, and soon the wires are close strung with their forms. The fact that night after night they are permitted peacefully to sleep here above the street bespeaks a pleasing relation between bird and man.

On the crest and upper slopes of Ancon Hill is a small area of the forest growth that covered the greater part of the hill before it was appropriated to the wants of men. The trees are not high but the vegetation is dense and affords excellent cover for the birds that still remain to represent the original avifauna. How many of them there are I do not know, for I have passed only a part of one morning in these woods. But I saw several species I have not seen elsewhere in Ancon, including Gould's Manakin, the Yellow-green Pachysylvia, and the Talamanca Jay; and search would no doubt result in the discovery of other species that are now isolated in this island in the air. I, however, was intent on meeting one bird, for it is of record that on this hill there once lived one of the Chestnut-backed Wrens whose song had haunted me ever since I had heard it at Pacora.

The road that climbs the hill is bare and desolate, and it is not until one arrives at the summit that he reaches the forest. From this point, nearly 700 feet above the sea, one may sweep the horizon as from a tower. It is not alone the exceptional diversity, beauty, and grandeur of the view, but also the significance of things seen that arouses one's enthusiasm. Taboga, whence Pizarro sailed, and old Panama, scene of Morgan's raid, make the "Conquest of Peru" and the treasures of the Inca seem almost as real as current history. To see bull-ring and ball-field at a glance and the cities of Panama and Ancon lying side by side is to contrast vividly expressions of two cultures. The wide-spreading, graceful pavilions of the Gorgas Hospital tell an unequaled story of man's conquest of disease, and the narrow silver line of the Canal leading to the Miraflores locks is, in part, one of the fruits of this victory. The administration building, the orderly rows of attractive dwellings, the docks and machine shops at Balboa are all parts of the machine through which Canal Zone life functions flawlessly. The airplanes above their field, the troops at Amador, the fortified islands beyond, and the men-of-war at anchor in the bay are symbols of protection and hence of peace. And as I entered the forest and was greeted by the exquisitely pure, mellow, appealing

notes of the Wren I had come to hear, I asked myself where could one find deeper inspiration from the beauties of nature, the romance of history, the works of man, and the songs of birds?

APPENDIX

A LIST OF BIRDS OF BARRO COLORADO

For reference purposes, and to give a more complete conception of the extent of Barro Colorado's bird-life than can be gained from the preceding pages, I append a nominal list of the birds I have seen on and from the island. The records of other observers would add about thirty more, and at least forty others may be expected to occur, making the total number of island birds about 280.

Comparatively few tropical birds, particularly the smaller species, have specific common names. Those here given are, for the greater part, translations or adaptations of their technical names. It is unfortunate that these often cumbersome, inappropriate, if not actually misleading titles are the only ones available.

The nomenclature employed is that of Mrs. Sturgis' useful "Field Book of Birds of the Panama Canal Zone" (Putnam's) which follows current usage.

The names of migrants from North America are preceded by an asterisk.

The Tinamous. Family Tinamidæ

Chestnut-headed Tinamou (*Tinamus major castaneiceps*).
Pileated Tinamou (*Crypturus soui panamensis*).

The Curassows and Guans. Family Cracidæ

Crested Guan (*Penelope cristata cristata*).
Gray-headed Guan (*Ortalis cinereiceps cinereiceps*).

The Quails and Partridges. Family Perdicidæ

Marbled Guiana Quail (*Odontophorus guianensis panamensis*).

APPENDIX

The Pigeons and Doves. Family Columbidæ

Scaled Pigeon (*Columba speciosa*).
Pale-vented Pigeon (*Columba rufina pallidicrissa*).
Short-billed Pigeon (*Columba nigrirostris*).
Blue Ground Dove (*Claravis pretiosa*).
Verreaux's Dove (*Leptotila verreauxi verreauxi*).
Cassin's Dove (*Leptotila cassini cassini*).

The Rails, Coots and Gallinules. Family Rallidæ

Cayenne Wood Rail (*Aramides cajanea cajanea*).
White-throated Crake or Rail (*Creciscus albigularis*).
Purple Gallinule (*Ionornis martinica*).

The Grebes. Family Colymbidæ

Pied-billed Grebe (*Podilymbus podiceps*).

The Snipe, Sandpipers, and Their Allies Family Scolopacidæ

*Spotted Sandpiper (*Actitis macularia*).

The Jacanas. Family Jacanidæ

Black Jacana (*Jacana nigra*).

The Herons. Family Ardeidæ

Great Blue Heron (*Ardea herodias herodias*).
Louisiana Heron (*Hydranassa tricolor ruficollis*).
Little Blue Heron (*Florida cærulea cærulea*).
Green Heron (*Butorides virescens virescens*[1]).
Streaked Heron (*Butorides striata*).
Black-crowned Night Heron (*Nycticorax nycticorax nævius*).
Cabanis' Tiger Bittern (*Tigrisoma cabanisi*).
Least Bittern (*Ixobrychus exilis*).

[1]Breeds.

The Gulls and Terns. Family Laridæ

Laughing Gull (*Larus atricilla*).
Royal Tern (*Sterna maxima*).

The Pelicans. Family Pelecanidæ

Brown Pelican (*Pelecanus occidentalis*).

The Cormorants. Family Phalacrocoracidæ

Brazilian Cormorant (*Phalacrocorax vigua vigua*).

The Anhingas or Snake Birds. Family Plotidæ

Snake Bird (*Anhinga anhinga*).

The Frigate Birds. Family Fregatidæ

Frigate Bird (*Fregata magnificens rothschildi*).

The American Vultures. Family Cathartidæ

King Vulture (*Gypagus papa*).
Black Vulture (*Catharista urubu*).
Turkey Buzzard (*Cathartes aura aura*).

The Hawks, Eagles and Their Allies
Family Accipitridæ

Red-throated Caracara (*Ibycter americanus americanus*).
*Marsh Hawk (*Circus hudsonius*).
Black and White Hawk (*Micrastur melanoleucus*).
*Broad-winged Hawk (*Buteo platypterus platypterus*).
Large-billed Hawk (*Rupornis magnirostris ruficauda*).
Ghiesbrecht's Hawk (*Leucopternis ghiesbreghti costaricensis*).
Semiplumbeous Hawk (*Leucopternis semiplumbea*).
Black and White Hawk (*Spizastur melanoleucus*).
Swallow-tailed Kite (*Elanoides forficatus yetapa*).

APPENDIX

The Falcons and Osprey. Family Falconidæ

White-throated Bat Falcon (*Falco albigularis*).
*Osprey (*Pandion haliaëtus carolinensis*).

The Owls. Family Bubonidæ

Spectacled Owl (*Pulsatrix perspicillata*).
Choliba Screech Owl (*Otus choliba luctisonus*).
Cassin's Barred Owl (*Ciccaba virgata virgata*).

The Parrots. Family Psittacidæ

Tovi Parrakeet (*Brotogeris jugularis*).
Salvin's Parrot (*Amazona autumnalis salvini*).
Plain-colored Parrot (*Amazona farinosa inornata*).
Blue-headed Parrot (*Pionus menstruus*).

The Kingfishers. Family Alcedinidæ

Ringed Kingfisher (*Megaceryle torquata torquata*).
*Belted Kingfisher (*Megaceryle alcyon alcyon*).
Amazon Kingfisher (*Chloroceryle amazona*).
Isthmian Green Kingfisher (*Chloroceryle americana isthmica*).

The Motmots. Family Momotidæ

Great Rufous Motmot (*Baryphthengus martii semirufa*).
Lesser Broad-billed Motmot (*Electron platyrhynchus minor*).

The Goatsuckers. Family Caprimulgidæ

Parauque (*Nyctidromus albicollis albicollis*).

The Potoos. Family Nyctibiidæ

Poor-me-One (*Nyctibius griseus panamensis*).
Great Potoo (*Nyctibius grandis*).

The Swifts. Family Cypselidæ

Chapman's Swift (*Chaetura chapmani*).

The Hummingbirds. Family Trochilidæ

Rucker's Hermit (*Threnetes ruckeri dariensis*).
Lesser Hairy Hermit (*Glaucis hirsuta affinis*).
Bang's Hermit (*Phæthornis guyi coruscus*).
Dusky Hermit (*Phæthornis adolphi nelsoni*).
Jacobin Hummingbird (*Florisuga mellivora*).
Duchassain's Hummingbird (*Lepidopyga cæruleogularis*).
Rieffer's Hummingbird (*Amazilia tzacatl tzacatl*).
Panama Hummingbird (*Damophila panamensis*).
Colombian Wood Nymph (*Thalurania columbica columbica*).
Buffon's Plumeleteer (*Chalybura buffoni micans*).
Black-throated Mango (*Anthracothorax nigricollis nigricollis*).
Barrot's Fairy (*Heliothryx barroti*).

The Trogons. Family Trogonidæ

Graceful Trogon (*Trogonurus curucui tenellus*).
Gartered Trogon (*Chrysotrogon caligatus*).
White-tailed Trogon (*Trogon strigilatus chionurus*).
Massena Trogon (*Curucujus massena massena*).

The Cuckoos. Family Cuculidæ

Central American Squirrel Cuckoo (*Piaya cayana thermophila*).
Salvin's Ground Cuckoo (*Neomorphus salvini salvini*).
Pheasant Cuckoo (*Dromococcyx phasianellus*).
Ani (*Crotophaga ani*).

The Toucans. Family Rhamphastidæ

Short-keeled Toucan (*Rhamphastos piscivorus brevicarinatus*).
Swainson's Toucan (*Rhamphastos swainsonii*).
Collared Aracari (*Pteroglossus torquatus torquatus*).

APPENDIX

The Puffbirds. Family Bucconidæ

Dyson's Puffbird (*Notharchus hyperrhynchus leucocrissus*).
Panama Pied Puffbird (*Notharchus tectus subtectus*).
Panama Malacoptila (*Malacoptila panamensis panamensis*).

The Woodpeckers. Family Picidæ

Wagler's Woodpecker (*Centurus rubricapillus wagleri*).
Pucheran's Woodpecker (*Tripsurus pucherani pucherani*).
Fraser's Woodpecker (*Celeus loricatus loricatus*).
Malherbe's Woodpecker (*Scapaneus malherbii*).
Panama Pileated Woodpecker (*Ceophlœus lineatus mesorhynchus*).

The Antbirds or Antthrushes. Family Formicariidæ

Fasciated Antshrike (*Cymbilaimus lineatus fasciatus*).
Black-crested Antshrike (*Thamnophilus doliatus nigricristatus*).
Slaty Antshrike (*Thamnophilus punctatus atrinuchus*).
Surinam Antwren (*Myrmotherula surinamensis*).
Lawrence's Antwren (*Myrmotherula fulviventris*).
Black Antwren (*Myrmotherula axillaris albigula*).
Panama Antwren (*Microrhopias quixensis virgata*).
Tyrannine Antbird (*Cercomacra tyrannina rufiventris*).
White-bellied Antbird (*Myrmeciza longipes panamensis*).
Sclater's Antbird (*Myrmeciza exsul exsul*).
Panama Antthrush (*Formicarius analis panamensis*).
Bicolored Antbird (*Gymnopithys bicolor bicolor*).
Spotted Antbird (*Hylophylax nævioides nævioides*).
McLeannan's Antthrush (*Phœnostictus mcleannani mcleannani*).
Lawrence's Antpitta (*Hylopezus perspicillatus perspicillatus*).

The Ovenbirds and Their Allies. Family Furnariidæ

Pale-throated Automolus (*Automolus pallidigularis pallidigularis*).
Mexican Xenops (*Xenops genibarbis ridgwayi*).
Mexican Sclerurus (*Sclerurus mexicanus anomalus*).

The Woodcreepers.[1] Family Dendrocolaptidæ

Northern Wedgebill (*Glyphorhynchus cuneatus pectoralis*).
Brown Dendrocincla (*Dendrocincla lafresnayi ridgwayi*).
Lawrence's Woodcreeper (*Xiphorhynchus nanus nanus*).
Black-striped Woodcreeper (*Xiphorhynchus lachrymosus lachrymosus*).
White-throated Woodcreeper (*Dendroplex picus panamensis*).

The American Flycatchers. Family Tyrannidæ

Equinoctial Flycatcher (*Craspedoprion æquinoctialis*).
Yellow-margined Flycatcher (*Rhynchocyclus marginatus*).
Northern Tody Flycatcher (*Todirostrum cinereum finitimum*).
Slate-headed Tody Flycatcher (*Todirostrum schistaceiceps*).
Lawrence's Bent-billed Flycatcher (*Oncostoma olivaceum*).
Bangs' Pipromorpha (*Pipromorpha oleaginea parca*).
Yellow-bellied Camptostoma (*Camptostoma pusillum flaviventre*).
Lawrence's Elænia (*Elænia chiriquensis chiriquensis*).
Striped Flycatcher (*Legatus leucophaius leucophaius*).
Smooth Flycatcher (*Sublegatus arenarum glaber*).
Cayenne Flycatcher (*Myiozetetes cayenensis harterti*).

[1] Commonly called "Woodhewers," but they are not hewers of wood and there is no reason why the error in their technical name should be repeated in their common name. Woodcreeper is more appropriate.

Colombian Flycatcher (*Myiozetetes similis columbianus*).
Lictor Flycatcher (*Pitangus lictor panamensis*).
Noble Flycatcher (*Myiodynastes maculatus nobilis*).
Boat-billed Flycatcher (*Megarhynchus pitangua mexicanus*).
Colombian Royal Flycatcher (*Onychorhynchus coronatus cristatus*).
Brown Flycatcher (*Cnipodectes subbrunneus subbrunneus*).
Sulphur-rumped Myiobius (*Myiobius sulphureipygius aureatus*).
Black-tailed Myiobius (*Myiobius atricaudus atricaudus*).
Fulvous-throated Flycatcher (*Terenotriccus erythrurus fulvigularis*).
*Traill's Flycatcher (*Empidonax traillii traillii*).
*Crested Flycatcher (*Myiarchus crinitus*).
Panama Flycatcher (*Myiarchus ferox panamensis*).
Black-crested Flycatcher (*Myiarchus tuberculifer brunneiceps*).
*Kingbird (*Tyrannus tyrannus*).
Lichtenstein's Kingbird (*Tyrannus melancholicus chloronotus*).

The Manakins. Family Pipridæ

Red-headed Manakin (*Pipra mentalis ignifera*).
Gould's Manakin (*Manacus vitellinus vitellinus*).
Russet Manakin (*Scotothorus amazonus stenorhynchus*).
Rufous Manakin (*Laniocera rufescens*).

The Cotingas. Family Cotingidæ

Costa Rican Tityra (*Tityra semifasciata costaricensis*).
Fraser's Erator (*Erator albitorques fraseri*).
Cinnamon Becard (*Pachyrhamphus cinnamomeus*).
Panama Lathria (*Lathria unirufa*).

Rufous Lipaugus (*Lipaugus holerythrus holerythrus*).
Sclater's Attila (*Attila brasiliensis sclateri*).
Natterer's Cotinga (*Cotinga nattereri*).
Purple-throated Fruit Crow (*Querula purpurata*).

The Swallows. Family Hirundinidæ

Mangrove Swallow (*Iridoprocne albilinea*).
*Barn Swallow (*Hirundo erythrogaster*).
Gray-breasted Martin (*Progne chalybea chalybea*).
Panama Rough-winged Swallow (*Stelgidopteryx ruficollis uropygialis*).

The Kinglets, Gnatcatchers and Their Allies. Family Sylviidæ

Lawrence's Gnatcatcher (*Polioptila superciliaris superciliaris*).
Long-billed Antwren (*Ramphocænus rufiventris rufiventris*).

The Wrens. Family Troglodytidæ

Bay Wren (*Thryophilus castaneus castaneus*).
Galbraith's Wren (*Thryophilus galbraithi galbraithi*).
Panama Black-billed Wren (*Pheugopedius fasciato-ventris albigularis*).
Panama House Wren (*Troglodytes musculus inquietus*).
Sclater's Wood Wren (*Henicorhina prostheleuca prostheleuca*).
Lawrence's Musician Wren (*Leucolepis phæocephalus lawrencei*).

The Mockingbirds, Thrashers and Catbirds. Family Mimidæ

*Catbird (*Dumetella carolinensis*).
*Wood Thrush (*Hylocichla mustelinus*).[1]

[1] December 29, 1926, only record.

APPENDIX

The Vireos. Family Vireonidæ

Yellow-green Vireo (*Vireosylva flavoviridis flavoviridis*).
*Red-eyed Vireo (*Vireosylva olivacea*).
Panama Shrike-Vireo (*Vireolanius pulchellus viridiceps*).
Gray-headed Pachysylvia (*Pachysylvia decurtata*).

The American Warblers. Family Mniotiltidæ

*Black and White Warbler (*Mniotilta varia*).
*Prothonotary Warbler (*Protonotaria citrea*).
*Golden-winged Warbler (*Vermivora chrysoptera*).
*Yellow Warbler (*Dendroica æstiva æstiva*).
*Chestnut-sided Warbler (*Dendroica pensylvanica*).
*Bay-breasted Warbler (*Dendroica castanea*).
*Northern Water-Thrush (*Seiurus noveboracensis noveboracensis*).
*Kentucky Warbler (*Oporornis formosus*).
*Mourning Warbler (*Oporornis philadelphia*).
*Maryland Yellowthroat (*Geothlypis trichas trichas*).
Sclater's Warbler (*Basileuterus rufifrons mesochrysus*).

The Finches. Family Fringillidæ

Panama Blue Grosbeak (*Cyanocompsa cyanoides cyanoides*).
Hicks' Seedeater (*Sporophila aurita*).
Slate-colored Grosbeak (*Pitylus grossus saturatus*).
Panama Buff-throated Saltator (*Saltator intermedius*).
Panama Streaked Saltator (*Saltator striatipectus isthmicus*).
*Dickcissel (*Spiza americana*).

The Honeycreepers. Family Coerebidæ

Mexican Bananaquit (*Cœreba mexicana mexicana*).
Ultramarine Dacnis (*Dacnis cyana ultramarina*).

Blue Honeycreeper (*Cyancrpes cyaneus cyancus*).
Northern Green Honeycreeper (*Chlorophanes spiza arguta*).

The Tanagers. Family Tangaridæ

Fulvous-vented Euphonia (*Tanagra fulvicrissa*).
Thick-billed Euphonia (*Tanagra crassirostris*).
Plain-colored Tanager (*Tangara inornata languens*).
Mrs. Wilson's Tanager (*Tangara larvata centralis*).
Blue Tanager (*Thraupis cana diaconus*).
Black-winged Palm Tanager. (*Thraupis palmarum atripennis*).
Yellow-rumped Tanager (*Ramphocelus icteronotus*).
Panama Crimson-backed Tanager (*Ramphocelus dimidiatus isthmicus*).
*Summer Tanagcr (*Piranga rubra rubra*).
*Scarlet Tanager (*Piranga erythromelas*).
Dusky-tailed Ant-Tanager (*Phœnicothraupis fuscicauda*).
Boddært's Tanager (*Tachyphonus rufus*).
White-shouldered Tanager (*Tachyphonus luctuosus panamensis*).
Gray-crested Tanager (*Eucometis cristata*).

The American Orioles, Grackles and Their Allies. Family Icteridæ

Wagler's Oropéndola (*Zarhynchus wagleri waglcri*).
Lawrence's Cacique (*Cacicus vitellinus*).
Colombian Rice Grackle (*Cassidix oryzivora mexicana*).
*Baltimore Oriole (*Icterus galbula*).

The Crows, Jays and Magpies. Family Corvidæ

Talamanca Jay (*Cyanocorax affinis zeledoni*).

INDEX

Afterglow, tropical, 251.
Agouti, eaten by Puma, 207; eats almendro nuts, 57; flashlighted, 216.
Allee, W. C., his studies on Barro Colorado, 15.
Allen, A. A., quoted, 364.
Almendro, large, on Wheeler Trail, 193; as food tree, 56, 193.
Alouatta palliata inconsonans, habits of, 291.
Amazilia tzacatl, feeding habits of, 58.
Ancon Hill, bird-life of, 390; view from, 397.
Ani, Common, habits of, 71; notes of, 380. Groove-billed, notes of, 380.
Antbird, Bicolored, notes of, 185; with army ants, 185. McLcannan's, with army ants, 185. Sclater's, notes of, 184, 267. Spotted, notes of, 185; with army ants, 185. White-bellied, call of, 277.
Antbirds, calls of, 43.
Anteatcr, Great, unknown on island, 217. Two-toed, 262.
Anthony, H. E., paper on bats by, 216.
Antpitta, Lawrence's, notes of, 183; figured, 183.
Ants, army, accompanied by birds, 185.
Antshrike, Black-crested, figured, 393. Fasciated, notes of, 277.
Ant-Tanager, calls of, 183; colors of, 360; song of, 270.
Aotus zonalis, habits of, 283.
Apeiba aspera, fruit of, eaten by parrots, 173.
Attila, Sclater's, call of, 278, 382.
Audubon, J. J., on sensc of smell in Turkey Buzzard, 150.
Autophotographs, valuc of, 205.

Bachman, John, on scnse of smell in Turkcy Buzzard, 151.
Baerg, W. J., his studies on Barro Colorado, 16.
Baird, S. F., on bird migration, 353.
Balsa, as food tree, 45.
Barbour, Thomas, dedication to, v; refercnce to, 2.
Barro Colorado Island, as an Ark, 4; changes in fauna of, 11; fauna of, 3; habitat group from, 18; how formed, 1; insulation of, 5, 7, 8; list of birds of, 399; origin of name of, 7; photography on, 18; position of, 2; proximity to mainland of, 7, 235; scttlers on, 10; shoreline of, 10; size of, 1; topography of, 6; value to naturalists, 3, 11–14, 17.
Bats, feeding-tablc for, 22; flashlighted, 215; fly into trip-wire, 215.
Beebe, William, on relation bctwcen color and habitat in birds, 359.
Bees, Stingless, swarm of, 65.
Binocular, 24-power, value of, 24.
Birds, arboreal, 355, 356; associations of, 350; collcction of, 346; colors of, 356; comparative numbcrs of, 349, 351; concealed by vegetation, 346; difficulties of

identification of, 347; enemies of, 361; food and haunts, 356; local distribution of, 376; mortality among, 362; of gardens, 390; sedentary, 9; terrestrial, 354; vertical distribution of, in forests, 353, 372; wide-ranging, 8.
Bittern, Least, on grassy islands, 243.
Bladder-wort, as island-maker, 237.
Blossoms, fallen, on trail, 189.
Bombacopsis fendleri, on Allison Armour Trail, 194.
Bombax, at Pacora, 381; on the trail, 182.
Bot-fly, larvæ of, in monkeys, 311.
Brocket, rare on island, 216.
Buzzard, Turkey, and King Vulture, 377; flashlight of, 150; flight of, 73; migration of, 147; number on Barro Colorado, 148; over Ancon Hill, 395; power of sight of, 149; range of, 9; sense of smell in, 147.

Cacique, Lawrence's, song of, 273.
Camera-trap, setting, 199; baiting, 201.
Canal Zone, map of, 2; life in, 391.
Capucin Monkey, drinking from balsa blossom, 46; habits of, 285.
Car, French, on the trail, 182.
Caracara, Red-throated, food of, 172; voice of, 172.
Cassidix oryzivora, parasitic on Oropéndolas, 107.
Catharus frantzi, song of, 254.
Cayuca, use of, 220.
Cebus capucinus imitator, food of, 289; habits of, 285; haunts of, 288; voice of, 288.
Cedar, spiny, on Allison Armour Trail, 193.
Cercomacra tyrannina rufiventris, call of, 43.
Clark, Dr. Herbert, quoted, 9.
Claudia, history of, 313–326.
Clearing, birds settle in, 9, 10; description of, 25; life of, 34–77; view from, 25, 30.
Climate of Barro Colorado, 26, 36, 84.
Coati, abundance of, 341; as enemy of birds, 364; attacks man, 332, 344; destructiveness of, 74, 343; eats papaya, 74; enemies of, 339; explodes flashlight, 199; family life of, 333; food of, 332, 342; habits of, 327–345; hunting by, 328; in almendro tree, 56; personality of, 330; pugnaciousness of, 337, 343; sense of smell of, 23, 327; sex rivalry in, 339; tail, use of, 327, 332; taming of, 334, 336; used as bait, 158; young, obedience of, 329.
Coloration, protective, in Purple Gallinule, 243; in Jacana, 248.
Colors of birds in relation to habitat, 357; significance of, 361.
Conejo Pintado, unknown on island, 217.
Cordia aliodora, bloom of, 31.
Cormorants, on Gatun Lake, 29; roosting in dead trees, 241.
Cotinga, Natterer's, call of, 277; colors of, 123; feeding young, 126; figured, 125; loss of nest by, 128, 131; relation of sexes in, 130; return to nest-site, 129; young of, 125.
Coumarouna panamensis, fruit eaten, 56.
Cuckoo, Squirrel, notes of, 63; figured, 62.

INDEX

Curran, C. H., his studies on Barro Colorado, 16.
Cycle, physiological of Oropéndola, 85.

Day, coming of, 38; end of, 75.
Deer, White-tailed, eaten by Puma, 207; rare on island, 216.
Didymopanax morototoni, as food tree, 45.
Dove, Cassin's, habits of, 180; history of, 180.
Ducks, Black-bellied Tree, at Pacora, 388.
Dunn, E. R., his studies on Barro Colorado, 16.

Eagle Hawk, attacks Oropéndolas, 105.
Eggs, number laid by birds in tropics, 67, 101.
Estero, beauty of, 230.
Eucometis cristata, with army ants, 186.

Falcon, White-throated Bat, as moth-catcher, 240; figured, 241.
Ficus, loses and regains foliage, 170.
Fig, Strangler, as resort for Monkeys, 170; in museum group, 170; killing trees, 175.
Fig-tree, fruits of, eaten, 190.
Fish, dead, used to attract Turkey Buzzards, 157, 158.
Flycatcher, Colombian, nesting of, 65. Noble, nesting, 59.
Food Trees, 44.
Forest, flowering trees of, 31; gallery bordering savanna and marsh, 379; luxuriance of, at water's edge, 230; mature, 192, 194; voices of, 194.
Formicarius analis, notes of, 43, 184; figured, 184.
Fruit Crow, habits and voice of, 278.
Fuertes, Louis Agassiz, quoted, 259.
Fuirena umbellata, as island maker, 237.

Gaige, F. M., his studies on Barro Colorado, 16.
Gallinule, Purple, colors of, in nature, 243; figured, 246; habits of, 243; notes of, 246.
Gato Solo. *See* Coati.
Gatun Dam, effects of closing, 1, 5.
Gatun Lake, birds of, 29.
Goldman, E. A., quoted, 311.
Grosbeak, Blue, song of, 272. Slate-colored, song of, 273.
Gross, A. M., studies on Barro Colorado, 17.
Gross, William, on feeding habits of Cedar Waxwing, 127.
Guan, as drummer, 40; in mangabé tree, 52; in sandbox tree, 61.
Guans, Crested, eating figs, 191; notes of, 174.
Guayacan, blooming of, 26.
Gull, Laughing, crossing Isthmus, 29; robs Brown Pelican, 394.

Habitat and color, 365, 369.
Hawk, Ghiesbrecht's, call, 60; color, 60; food, 61; nest, 61. Large-billed, notes of, 383. Laughing, notes of, 380.
Heron, Green, on grassy islands, 243.
Herpetotheres cachinnans, notes of, 380.
Honeycreeper, Blue, conspicuous on ground, 371; insignificant notes of, 279.

Humidity, affecting colors of birds, 359, 372.
Hummingbird, Black-throated, aggressiveness of, 133; attacks Cassidix, 137; attacks Trogon, 144; feeding young, 135; figured, 135, 138, 143; first flight of, 139; nests in sandbox tree, 122, 132; relations of sexes in, 135; return to nest-site, 136; second brood of, 146; young of, 134, 138.
Hylopezus perspicillatus, call of, 43.

Iguana, as food for other animals, 10; hunts nest-site, 34.
Instinct, developed by experience, 94.
Institute for Research in Tropical America, on Barro Colorado, 1, 15; future of, 18.
Islands, grassy, formation of, 236.

Jacanas, at Pacora, 387; colors of, in nature, 247.
Jacaranda copaia, bloom of, 31, 189.
Jaguar, unknown on island, 207, 208, 217.
Jay, Talamanca, 280; figured, 280.
Juan, a bird mystery, 223.

Kenoyer, L. A., his studies on Barro Colorado, 15.
Kingbird, migrating, 9.
Kingfisher, Isthmian, notes of, 242. Ringed, notes of, 242.
Kirby, H., his studies on Barro Colorado, 16.

Laboratory of Institute for Research in Tropical America, 1, 2, 18.
Lawrence, George N., collection of, 181.
Leaves, fresh colors of, 189.
Legatus leucophaius, parasitic on Cayenne Flycatcher, 119; on Oropéndolas, 111; notes of, 43, 111; nesting of, 114.
Leistes militaris, on savanna, 378.
Leontecebus geoffroyi, habits of, 283.
Leucolepis dichrous, voice of, 267.
Life, modern, confusion of, 33.
Lutz, F. E., his studies on Barro Colorado, 16.

Macronomum glabrescens, bloom of, 31, 57, 187.
Madroño, flowering of, 57.
Man, unknown, flashlighted, 218.
Manakin, Gould's, notes of, 178. Red-capped, courtship of, 175; figured, 176.
Mangabé, as food tree, 50.
Man-o'-War Birds, crossing Gatun Lake, 29; encounter with Kingbird, 29.
Marmoset, drinking from balsa blossom, 231; habits of, 283.
Martin, Gray-breasted, attacks Hawk, 241; range of, 9; roosts near Presidencia, 395.
McLeannan, James, collecting at Lion Hill, 180.
Meadowlark, Panama, on savanna, 378. Western, song of, 40.
Migrants from North America, 352; routes of, 353.
Monkey, Howling, at dawn, 224, 238; clans of, 297; dead, eaten by Buzzards, 149; distance heard, 238; eating figs, 191; eating leaves, 46; family life of, 305; female of, 296; fly larvæ in, 305, 311; food of, 300; habits of, 291; male of, 295; number of, 298; roars in storm, 27; skull of, figured, 293; tail of, 302; voice of,

291; young of, 298, 308, 310, 313–326. Night, habits of, 283. Squirrel, habits of, 283. White-faced, habits of, 285.
Monkeys, curiosity of, 282.
"Monkeys' comb," fruit eaten by Parrots, 173.
Morpho, brilliancy of, 190, 231.
Morrow, Jay J., and Barro Colorado, 2.
Motmot, Broad-billed, calls of, 41. Rufous, calls of, 41; eats nutmegs, 47; figured, 42.
Myadestes unicolor, song of, 253.
Myrmeciza exsul, call of, 43; *longipes*, call of, 43.

Nasua narica, habits of, 327.
Natural rejection and birds' colors, 372.
Natural selection and birds' colors, 372.
Nesbit, William, and flashlight photography, 196.
Nesting season, time of, 37; mortality of, 363.
Nutmeg, as food tree, 47.

Ocelot, flashlighted, 209.
Ochroma limonensis, as food tree, 44.
"Old Timer" of Canal Zone, 374.
Opossum, flashlighted, 216.
Oriole, Baltimore, 222.
Oropéndolas, alarm-note of, 104, 105; and climate, 84; attacked by Owls, 106; building nest of, 91; call of, 43; courtship of, 97, 102; description of, 79; eggs of, 101; enemies of, 103; entering nest, 93; incubation by, 100; method of study of, 83; migration and, 86; on Barro Colorado, 79; origin of name, 78; period of incubation, 101; physiological cycle of, 85; relation between habit and safety in, 366; return to nest-site, 84; selection of nest-site, 86; sexual relations of, 99; song of, 98; sleep in nest, 101.
Owl, Spectacled, attacks Oropéndolas, 107; call of, 40.

Paca, unknown on island, 217.
Pacora Marshes, bird-life of, 374.
Parauque, at my house, 22; at Pacora, 381; in clearing, 261; song of, 38.
Paroquet, Tovi, captured by Coati, 371.
Parrot, Blue, flight of, 225; range of, 8; voice of, 225. Plain-colored, flight of, 225; range of, 8; voice of, 225. Salvin's, courtship of, 227; flight of, 225; mating habits of, 225; nesting habits of, 227; voice of, 225.
Parrots, colors of, in relation to haunts, 4; eat "monkeys' comb," 173; habits, haunts and color of, 367; in sandbox tree, 61.
Passiflora vitifolia, bloom of, 188.
Passion flower, blooming of, 188.
Pavo, in mangabé tree, 52.
Peccary, Collared, diurnal, 212; eating figs, 191; in the clearing, 74; odor of, 211; sense of smell, 210; stalked by Puma (?), 195. White-lipped, and trip-wire, 213; flashlighted, 209; flocking, 212.
Pelicans, Brown, crossing on Gatun Lake, 29; on Panama Bay, 394.
Photography, flashlight, joys of, 196; methods of, 197, 199, 203.
Pigeon, Black-billed, call of, 190. Scaled, range of, 8.
Pisote. *See* Coati.

Poor-me-One, song of, 262.
Protective coloration, need of, 361; theories of, 357, 361.
Puerco del Monte, flashlighted, 209; flocking, 212.
Puffbird, Dyson's, feeding habits of, 187. Pied, hiding method, 63.
Puma, and trip-wire, 213; flashlighted, 205–207; food of, 207; stalking Peccaries, 195; track of, 179; variations in numbers of, 207.

Quail, Wood, figured, 276; song of, 275.

Raccoons, unknown on island, 217.
Rail, White-throated in grassy islands, 250; figured, 250. Wood, song of, 238; figured, 239.
Ramphastos brevicarinatus, studied by J. Van Tyne, 368.
Rat, Spiny, flashlighted, 216.
Rau, Phil, his studies on Barro Colorado, 16.
Redwood House, 235.
Richter, C., his studies on Barro Colorado, 17.
Robin, Panama, song of, 395.
Rock salt, use as deer bait, 217.

Sandbox tree, at laboratory, birds of, 61; fall of, 119.
Savanna of Panama, birds of, 378.
Schmidt, C., his studies on Barro Colorado, 16.
Screech Owl, food of, 364.
Sedge, as island-maker, 237.
Shannon, Raymond, on Barro Colorado, 25.
Ships that pass Barro Colorado, 27.
Shiras, George, 3d, father of flashlight photography, 196.
Shrike Vireo, Panama, voice of, 44, 279.
Skunk, as bird enemy, 364.
Sloth, Three-toed, feeds on cecropia leaves, 4; as "Poor-me-One," 264.
Snipe, Wilson's, at Pacora, 386.
Snyder, T. E., his studies on Barro Colorado, 16.
Solitaires, songs of, 253.
Song-bird, what constitutes a, 257.
Songs of birds, time of, 38.
Sparrow, Song, colors of, 360.
Standley, P. C., on flora of Barro Colorado and of Canal Zone, 16.
Sterculia apetala, bloom of, 189.
Sturgis, B. B., book by, on Canal Zone birds, 17, 347, 399; quoted, 386.
Sunrise, time of, 38.
Swallow, Barn, as migrant, 352.

Tabebuia guayacan, bloom of, 31, 189; *pentaphyla*, bloom of, 31, 189.
Tanager, Blue, nesting of, 65. Palm, nesting, 59. Summer, as winter visitant, 352.
Tapir, crosses island, 214; eats banana, 214; flashlighted, 214, 233; on Wheeler estero, 232.
Tayra, as bird enemy, 362.
Teal, Blue-winged, at Pacora, 388.
Telegraph poles, resistance of, to termites, 171.
Termite House, 222.
Termites, studied, 16.
Thayer, Abbott, law of coloration of, 244, 248.
Tinamou, Chestnut-headed, colors of, 361, 369; figured, 260; sexing of, 260. Pileated, song of, 259.
Titi, habits of, 283.

INDEX

Toucan, Aracari, figured, 51. Short-keeled, monographed by J. Van Tyne, 17. Swainson's, call of, 50; feeding companion, 49; eating figs, 190; in nutmeg tree, 48.

Toucans, bill of, 52, 55; feeding habits of, 52; habits, haunts and color of, 368; lack group-impulse, 62.

Trails, animal life of, 196; as highways, 168; on Barro Colorado, 167.

Trees in forest, bark of, 192; impressiveness of, 192; size of, 193.

Triplaris americana, bloom of, 31, 189.

Trogon, Graceful, bill of, 55; figured feeding, 54. Massena, eats berries, 58; eats nutmegs, 48; Gross' studies of, 17.

Trogons, feeding at wasps' nests, 53, 62.

Tropics, defined, 253.

Tyrannus melancholicus, attacks Man-o'-War Bird, 29.

Tyrannus tyrannus, migrating, 63.

Utricularia mixta, as island-maker, 237.

Van Tyne, Josselyn, on colors of Toucans, 368; studies of, on Barro Colorado, 17.

Virola panamensis, as food tree, 45.

Voices of tropical birds, 252, 281.

Vulture, Black, 377; apparently attracted by dead Coati, 156; over Ancon Hill, 395. King, at Pacora, 377; attracted by dead fish, 158.

Warbler, Buff-rumped, song of, 279. Chestnut-sided, as winter visitant, 352; molt of, 352. Prothonotary, 222.

Warblers, voiceless in tropics, 279.

Waterton, Charles, quoted, 264.

Weston, W. H., Jr., experiments on sense of smell in Turkey Buzzard, 158; studies at Barro Colorado, 16.

Wheeler, W. H., his studies on Barro Colorado, 16.

Wichity, at Pacora, 388.

Wisslocki, G. B., his studies on Barro Colorado, 17.

Woodcreeper, Lawrence's, call of, 42; figured, 76.

Woodpecker, Malherbe's, nesting, 59. Pucheran's, nesting, 59. Wagler's, notes of, 383.

Wren, Bay, voice of, 269. Chestnut-backed, figured, 385; on Ancon Hill, 396; song of, 385. Galbraith's, song of, 384. Lawrence's, figured, 269; song of, 267. Panama House, at Pacora, 384; character of, 66; nesting of, 67; sleeping-quarters of, 22; voice of, 42, 67. Wood, figured, 265; song of, 265.

Zarhynchus wagleri, habits of, 78.

Zetek, James, dedication to, v; reference to, 2; studies of, 16.

WITHDRAWN

Date Due

MARYGROVE COLLEGE LIBRARY
My tropical air castle ; natur
574.986 C36
3 1927 00034908 1

574.986
C36

MARYGROVE
LIBRARY
DETROIT, MI